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Falkirk Uses New Methods

How Bath Tubs, Telegraph-Pole Bases and Other Castings Are Being Made in Old Scotch Foundry Town Using Modern American Machinery—Production Speeded Up—History of Falkirk Industry

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AFTER a well placed volley from our carronades we boarded her reeking decks." Many foundrymen, properly devoted to strong tales of history and adventure, are tolerably familiar in imagination with the short, squat, big-mouthed cannon used with such deadly effect at close quarters in naval battles and pirate chases toward the end of the eighteenth century, some few years before the dawn of steam took much of the romance out of combat. Carronades those guns were called. But how many foundrymen know that they were so named because the first ones were cast in the foundries of the Carron ironworks in Scotland, the establishment of which has led in the course of a century and a half to the development of one of the most interesting and unique iron-founding communities in the whole world?

The center of this community is Falkirk, a town of about 42,000 inhabitants located near the western end of the great Firth of Forth, about midway between Glasgow and Edinburgh. Falkirk has been devoted almost exclusively to iron founding for 165 years. During this time some 35 separate castings-making establishments have been set up around the original plant at the Carron Co., which, much enlarged, is still in operation. Out from Falkirk have gone men to all parts of the world carrying their conception of foundry work as a craft so highly skilled that it approaches the artistic. Those remaining with the shops in the district are of the sixth generation of molders. In addition to their acquired skill, they have the benefit of traditional and inherited ability going back to the days before the United States became a nation. The men of Falkirk are indeed proficient workers in sand and iron. Their peculiar skill is the product of settled habits and a somewhat isolated location, for the region around Falkirk is not a great iron consuming center. However, its castings go out to Africa, China, and the ends

FIG. 1—HINGED ROLL-UP FLASKS ARE USED FOR MOLDING BATH TUBS ACCORDING TO THE MODERN FALKIRK METHOD

Fig. 4—Below—The machine makes molds so fast that a special shake-out device is required. It straddles the sand heap and handles two molds at one time. It was built in the foundry and is said to work economically and rapidly

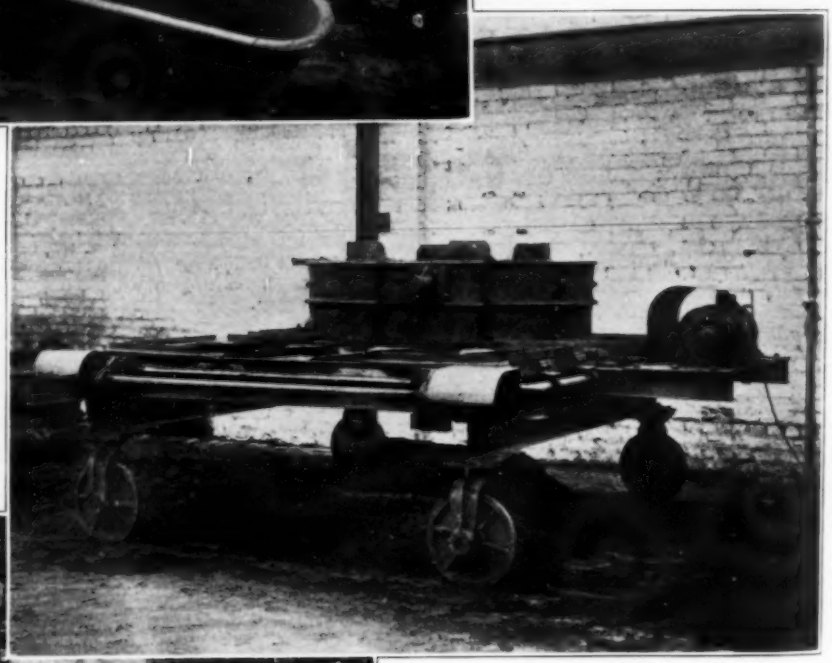


Fig. 2—Above—Falkirk molders making bath tubs by hand at the rate of three molds a day. With their heritage of six generations of skill these men are artists in their line. Special care is taken to avoid surface imperfections

Fig. 3—Left—The sand-throwing molding machine is revolutionizing the making of bath tubs in this old Scotch foundry center. The machine turns out as many molds in an hour as a molder and helper can make in a day by hand

of the earth. More of its history will be given at the end of this article.

Naturally by tradition and instinct the Falkirk worker clings to hand-molding methods, and in many cases the ability of the men is so highly developed that it is difficult to get them to take up the use of modern machinery. Falkirk is the last citadel of the do-it-by-hand type of foundry. This citadel is already invaded for the shops in the vicinity now are turning to the new world for molding machinery to speed production up to a twentieth century pace. The methods of the old carronade makers no longer suffice.

The leaders in this transformation of an ancient industry are a group of prominent Falkirk foundry owners who possess foresight and are not handicapped by that placidity and contentment which blinds some men to what is coming. Something over two years ago a group of these men, all prominent in the British National Light Castings association, spent several weeks in the United States studying the latest American developments in machine molding. The National Light Castings association embraces practically all the foundries in Great Britain engaged in the production of domestic iron products such as bath tubs, wash bowls, sinks, toilets, rain water and soil pipes, cast-iron eaves troughs, etc.

The result of the American visit was the organization of Foundry Plant & Machinery Ltd., to take over the British rights in the Beardsley-Piper sand-throwing molding machine. This company, managed by Daniel Sharpe, has its headquarters in Glasgow. The directors include Norman Cockburn, M. Cockburn & Co., Ltd., Falkirk; A. W. Steven, McDowall-Steven & Co., Ltd., Falkirk; H. J. Kennard, Falkirk Iron Co. Ltd., Falkirk; S. F. Corby, Doulton & Co., London; P. Deas, Thos. Allan Sons Ltd., Thornaby-on-Tees; D. M. King, David King & Sons, Ltd., Glasgow; and J. Learmonth, Planet Foundry Co., Guide Bridge, near Manchester.

Through the medium of this organization, sand-slinging molding machines of the Beardsley-Piper type now are being built completely in Great Britain and installed extensively in British foundries. The pioneer installations are in Falkirk. Thus one of the newest of American designed molding machines has become an important factor in the development of one of the oldest and most historic iron-founding districts in the English speaking world.

Bath tubs are one of the most important and widely distributed products of the foundries in the Falkirk district. Because of the size of the casting, the thin section of metal, and the necessity for obtaining an unblemished product which will take the enamel properly, the making of bath tubs falls particularly within the field of the highly skilled Falkirk floor molder working by hand in the traditional manner. In the face of this situation modern quantity-production methods have demonstrated their efficiency. The conditions against which machine molding is competing are such that tubs can be made by hand at a molding cost of about $2 each with a foundry loss of 4 to 6 per cent.

Among the oldest and best known producers of bath tubs and other plumbers' fittings in the Falkirk district are M. Cockburn & Co. who have been in business for nearly three quarters of a century. For making baths with the sand-slinging machine this company has laid out a special shop 42 feet wide and 225 feet long served by two 5-ton electric traveling cranes and amply lighted through the roof. Two 9-foot tractor type sand-throwing machines have been installed together with a special shaking-out device and a full outfit of iron flasks, patterns, etc. Two tracks have been laid for the sand-slinging machines, one on each side of the center line of the building. The machines operate on 440-volt, 3-phase, 50-cycle electricity. A simple gear on the driving pawl adjusts the speed of the machine through the sand heap to either 4 or 8 inches per minute. The sand heap is about 9 x 2 feet. The motors for these machines are made by Mather & Platt, Manchester. A 7½-horsepower motor is fitted to the impeller or sand-throwing head which usually operates at a speed of 1450 revolutions per minute. The tractor motor is also 7½ horsepower and the sand-sifter motor 1 horsepower. The motors are fitted with a solenoid-operated switch gear manufactured by the Igranic Electric Co., Bedford, England. However, in most respects the machines are similar in design and construction to those built

FIG. 5—GENERAL ARRANGEMENT OF SHOP FOR MOLDING BATH TUBS USING SAND-THROWING MACHINE

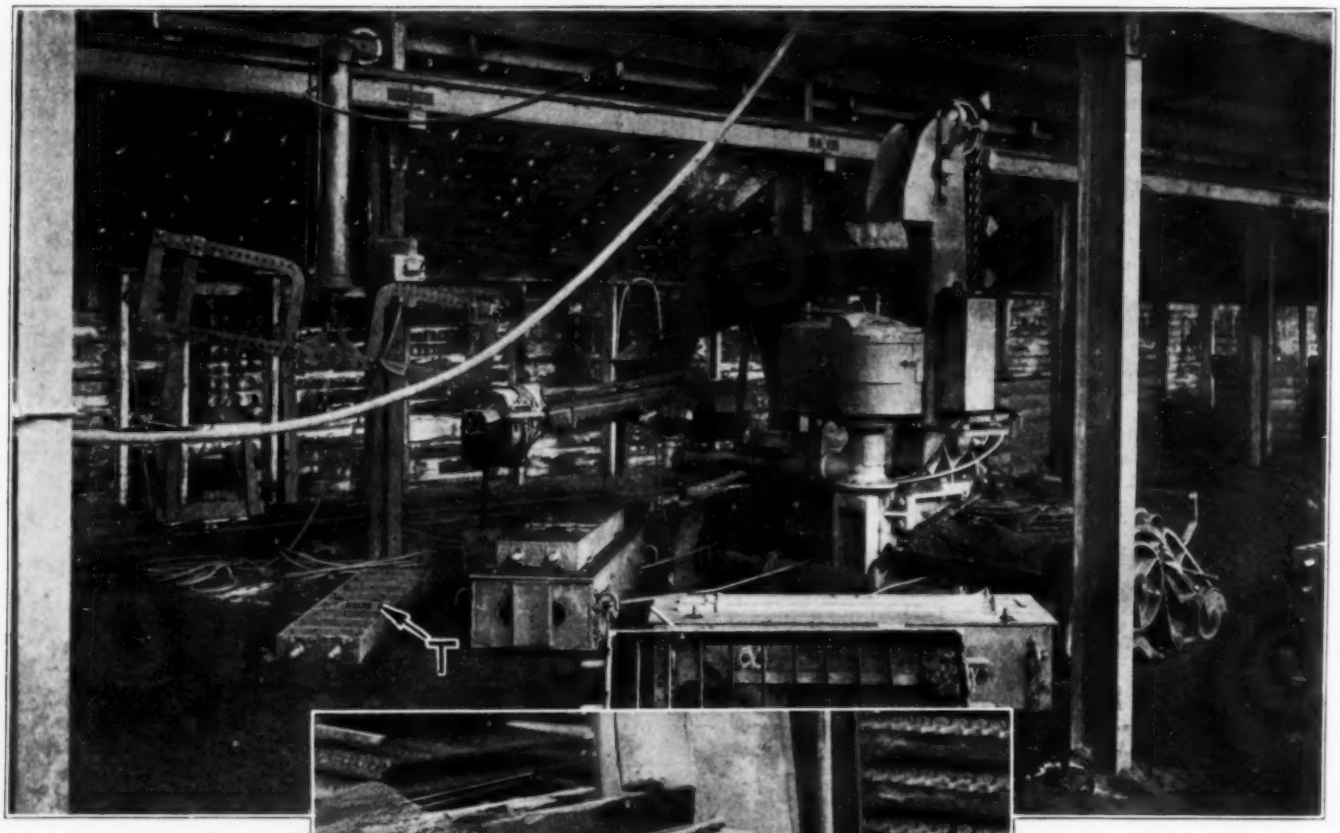


Fig. 6—Above—Sand Slinging Machine Rigged To Mold Telephone Pole Bases—Fig. 7—Right—The Corners Are Made by Hand

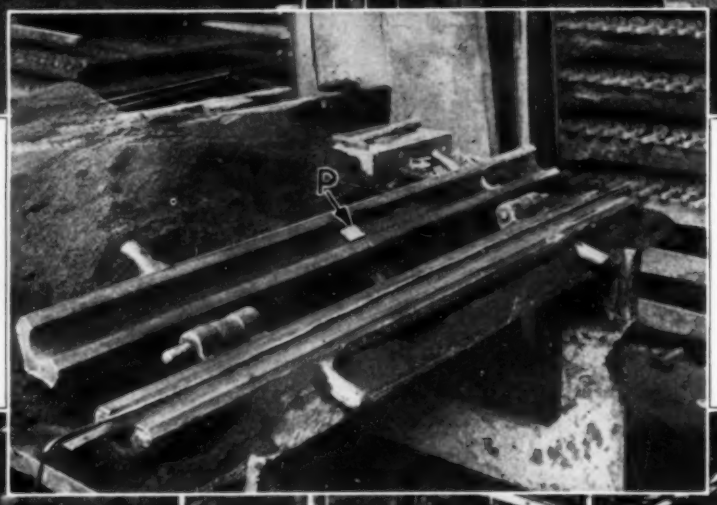
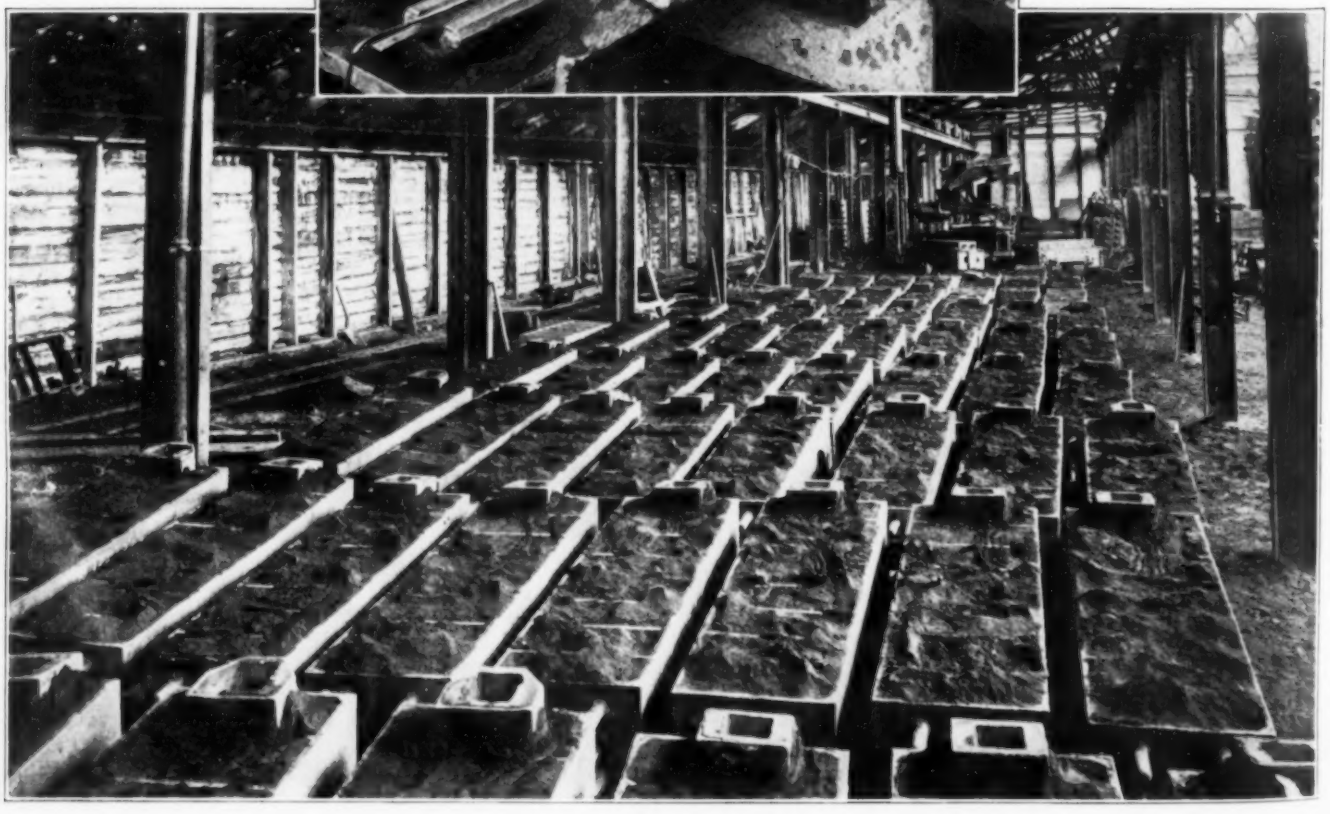


Fig. 8—Below—View of a Part of the Mornings Work Showing the Arrangement of the Pouring Basins



under the supervision of Messrs. Beardsley and Piper in Chicago.

The general arrangement of the machine molding department of the Cockburn foundries is shown in Fig. 5. When the machines reach the end of their travel they are picked up by one of the cranes and turned around or carried across the floor to the sand heap on the opposite side. The traveling cranes give flexibility to the whole arrangement and permit the machines to be used in any manner which may be most expedient.

The machines cut and riddle their own sand, the necessary new sand being added to the heap as required by drop-bottom buckets handled by the cranes.

The method of handling the job is clearly shown in Figs. 1, 3, and 5. Instead of being constructed in the usual manner providing for a straight lift, both the patterns and flasks are fitted with a roll-up hinge on one end. This simplifies both drawing the pattern and closing the mold and insures absolute steadiness in both operations. The flasks close over an extra long pin as shown. In the use of the hinged flask and in other directions this process differs from the standard American method described in THE FOUNDRY, Dec. 1, 1922, in which the application of the sand-slinger also was discussed.

For making 6-foot bath tubs at the rate of four or five per hour with three men and a boy the sand-slinging molding machine is arranged as shown in Fig. 3. These tubs have a metal section of only 3/16 inch, the finished casting weighing only 224 pounds. A soft fluid gray iron is used containing about 2.80 per cent silicon, 1.25 per cent phosphorus, and 0.02 per cent sulphur. It is poured exceedingly hot.

How the Mold Is Made

The pattern for the drag is shown at the left and that for the cope at the right in Fig. 3. Both are mounted on small cast-iron wheels so they can be towed along behind the sand-slinging machine. The drags and copes are molded alternately, and when completed the molds are set in a double row behind the machine as it makes its way along the floor. The rows of finished molds are shown in Fig. 5. The drag, shown on the floor at the right in Fig. 1, is fitted over the hinges on the drag pattern when being molded, the sand slinging head of the machine being passed over it with a long oval motion. In this way the drag half of the mold is rammed in from 2 to 2½ minutes. The middle portion of the drag is filled with an iron shell roughly corresponding to the shape of the tub which limits the thickness of the sand in the core, *A*, Fig. 1, to about 4 inches. This reduces the weight of the mold, saves time in ramming, and insures better venting, no pricking or direct venting being required. After the drag is rammed and rolled off the pattern it is rolled over by the crane and set down on the floor behind the machine.

The cope is next rammed on the pattern shown at the right in Fig. 3. This takes about 4½ minutes. There are eight bars in the cope across the top and an equal number of fins on each side which hold the sand firmly in place without gaggers or other supports. No stopping off or top ramming is necessary. The sand-slinging machine performs the whole operation of ramming and no finishing is necessary either on the copes or drags. After the cope itself is filled and rammed two frames are put on top to form the pouring basins. These are then finished by the machine the sand being rammed around a wood pattern which forms the basin and tops of the runners. After the pouring basins are finished the mold is rolled off the pattern. The crane tackle shown in Fig. 1 is used for this purpose. This tackle consists simply of an I-beam from which are suspended two iron slings that fit over the flask trunnions, the whole forming a yoke or bail by which the heavy flask can be handled readily by the traveling crane. The flask is not lifted straight off the pattern, but is rolled up on the hinges, *H*, Fig. 3. It is closed over the drag in a similar manner but just previous to this operation, the runner holes *R*, Fig. 1 are cleaned out with an air blast to be sure they are free from loose sand. Two runners lead down from each pouring basin to the gates *G* in the drag, the metal entering the mold from the bottom at four points.

The cupolas are located in another structure near the bath-tub shop. In common with the usual British practice they are placed outside the shop so as to facilitate charging and removing the debris from the day's heat. This is possible owing to the mild climate. Above the charging doors, the cupolas are brick. This is a type of construction peculiar to Falkirk. The metal is brought to the bath-tub shop in buggy ladles from which it is transferred to the large two-man hand ladles shown at the extreme left in Fig. 5. The molds are poured two up so that the metal enters all the gates simultaneously.

FIG. 9—THE TWO HALVES OF THE MOLD WITH ONE CORE SET

As soon as the metal is well set the top halves of the flasks are lifted off by the crane and shaken out on the apparatus shown in Fig. 4. This consists simply of a structural steel frame mounted on four wheels so that it will straddle the sand heap and provided with a motor-driven shaking or oscillating table actuated by cams. In this way both the cope and drag molds are shaken out quickly, the sand being returned to the heap from which it is picked up again by the sand-slinging machine during the next day's operations. The empty flasks are piled between the two sets of rails ready for the next day's work. The sand-slinging machine also cuts over, riddles, and prepares the sand, extracting any pieces of iron or foreign matter which may have become embedded in it. New sand is added to the heap from time to time as required by drop-bottom buckets han-

dled by means of the traveling cranes.

The hand molding methods which still are employed in another section of the Cockburn company's foundry are illustrated in Fig. 2. They form an interesting contrast to the modern machine-molding methods just described. Three part flasks are employed with straight lifts against flat slides mounted on the drags, the trunnions being at the ends instead of on the sides as in machine molding. The roll-up hinges, which are such a conspicuous feature of the machine molding methods, are not used. The flasks are considerably lighter in construction than those employed in machine molding. On the other hand using the sand-slinging machine, from four to five 6-foot tubs are made per hour by a gang of three men and a boy, the output being from 35 to 40 molds per day for each unit.

Making Telephone Pole Bases

Another important foundry in which the sand-slinging machine is being applied to lines of work which heretofore have lain exclusively within the province of the Falkirk type of skilled molder is that of McDowall Steven & Co. who operate what is known as the Laurieston Iron Works in the Falkirk district. This company turns out a great variety of miscellaneous castings, chiefly in the domestic field, including soil and rain-water pipes; cooking apparatus for hotels, institutions, and homes; stoves and grates; and boilers for hot water.

Two Beardsley-Piper sand-slinging molding machines have been installed by this company in a special department where they are utilized for a variety of work. The machines, which are of the 9-foot tractor type, operate in parallel bays that are 18 feet wide and 200 feet long, each bay being served by a crane of 16-foot span. One of the machines was imported direct from Chicago, this one being shown in Fig. 12 and the other, illustrated in Fig. 6, is a duplicate built in Glasgow. The crane which follows the sand-slinging machine carries an air hoist for handling the molds. The general arrangement of one of the two bays is shown in Fig. 8 with the machine and hoist in the background. A portion of the day's work is shown in the foreground.

One of the principal jobs now being handled on this floor are telegraph and telephone-pole bases for shipment abroad. The casting, which is about 4 feet long and weighs 33 pounds, is shown at the right in Fig. 9. It consists simply of a fairly thick tube with a 6-inch flange at the base supported by four ribs and a socket at the top to receive a length of ordinary gas pipe which forms the upper part of the pole. These castings are made to rigid specifications, each one being given a severe bending test. The castings are made of hard

FIG. 10—SPECIAL RIGGING HAS BEEN DEVELOPED FOR HANDLING THE MOLDS AND CORES

the machine molding department. The men in this department work in groups of two, consisting of a skilled molder and a young helper. The molders are veritable artists and great care is exercised in blacking and finishing the molds as well as in all other details of the process. Therefore, although the production by hand is only three molds per day for each man and helper, the foundry losses are exceedingly small in view of the fact that castings of only the highest quality without blemish will be accepted by the enameling department. Owing to the exacting standards which have been set up, these losses are around 5 to 6 per cent. With the machine it is inevitable that the loss should be somewhat higher, in the neighborhood of 10 to 12 per cent, although it is expected that as experience is acquired in the use of the machine the losses will diminish. This higher foundry loss is something of a handicap to strong iron without the use of steel in the cupola mixtures. This iron contains about 1.20 per cent phosphorus and 2.00 per cent silicon. The job is of a character which lends itself to repetition methods. The castings are molded in pairs in cast-iron flasks. Two cores are set in each mold. Each part of the flask is 5 feet in length, 16 inches in width and 6 inches in depth. The sides of the flask are ¾ inch in thickness and the ends ½ inch with gussets at the corners and heavy pin connections as shown. The two pins are both on one side of the flask. Two heavy trunnions are cast on each end of both the cope and drag to facilitate handling.

The sand-throwing machine tows into stripping-plate machines, one for the copes and one for the drags. These machines are towed on skids at an angle to the throwing machine to facilitate ramming. In the course of the day's work the sand-slinging machine pro-

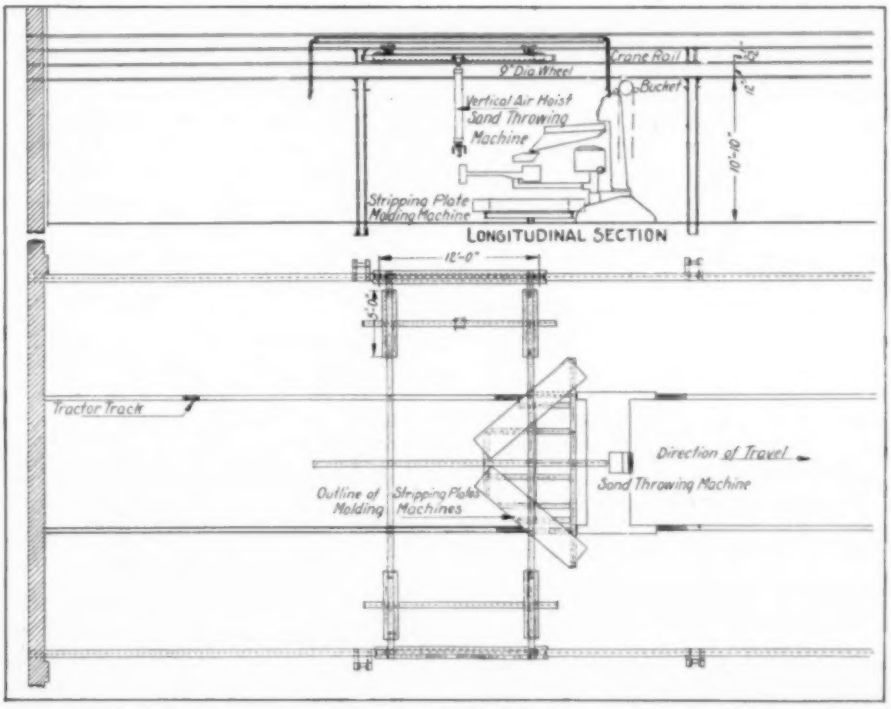


FIG. 11—SKETCH OF SAND-THROWING MACHINE LAYOUT IN A FALKIRK FOUNDRY

ceeds through the heap from one end of the floor to the other in the usual manner the flasks being piled on either side of the runway, the drags on the right and the copes on the left. When the machine reaches the end of the heap at the conclusion of the day's work, it is lifted off the floor by a chain hoist suspended from a heavy beam and turned around. The work starts at opposite ends of the floor each day. The stripping-plate machine for making the drags is shown in the foreground of Fig. 6 with the patterns in place ready to receive the flask which may be seen leaning against the machine. The sand heap is 10 feet wide and about 2 feet deep, the machine cutting and riddling the sand as it is used. The new sand is added every day by wheelbarrows, two or three barrow loads a day being sufficient to maintain the proper mixture.

The air hoist on the crane which follows the molding machine is connected with the main air supply of the shop by means of a hose. This hoist is of the direct-acting type with a 6-inch cylinder and a stroke of about 4 feet.

The copes and drags are rammed alternately. The operator of the ramming head is the only man in the gang who needs to have any particular skill and it has been found possible to train a man for this operation in a short time. To insure effective ramming along the sides of the flask, some sand is spilled over the edge, the ramming head being worked back and forth over the surface of the flask with a sweeping motion. On large deep molds it has been found advantageous in Falkirk to swing the head of the machine first clockwise and then counterclockwise. The machine is kept about 20 feet ahead of the nearest row of molds and the crane previously mentioned is used to transfer the finished molds from the machine to the floor. This crane is not towed by the machine, but is on ball bearings and is moved back and forth by hand.

The molds are handled by a special adjustable yoke which is shown clearly in Fig. 10. As will be noted, this yoke is ingeniously arranged so that the sockets in front of the handles at the lower end of the suspension members fit securely over the carrying pins on the ends of the flask. The holes bored in the frame of the yoke permit the suspension members to be adjusted quickly to flasks of different sizes if necessary. The suspension member at one end of the device is bolted rigidly to the two frame members of the yoke while on the other end, at the right in Fig. 10, it swings freely on the top bolt and is pinned temporarily to the bottom member after the sockets are fitted over the flask trunnions. By this arrangement a cope or drag may be picked up in a second and the heavy mold can be handled easily by two boys.

The flasks are arranged eight in a row behind the machine, the drags being set down first after which the two cores are set. The cores are brought to the floor by a hand barrow, also shown in Fig. 10, and two apprentices set the two cores at one time. The longitudinal position of the cores is regulated by gage points at their upper ends, as indicated in Fig. 9 in which the cope is shown on the right and the drag on the left. The long prints at each end of the mold center the cores accurately. The drag is provided with 10 bars which are notched to fit over the patterns. These bars hold the sand firmly in place so that no nailing is necessary on the sand surface. After the cores are set a small tinned screw *S*, Fig. 9 is placed carefully on the middle of the core shaft. When the cope is set in place the top of this screw bears against the bottom of a cast-iron block which is wedged to the middle bar as shown at *T*, Fig. 6. This gives the core a solid

FIG. 12—SAND-SLINGING MACHINE ARRANGED TO MOLD VALVE BODIES OF VARIOUS SIZES

support from the top and prevents it from floating upward in the middle when the metal is poured. No special facings are used except that a little plumbago is dusted on the upper end of the drag before the mold is closed.

The gate is at the upper end of the flask as shown in Fig. 9. It communicates with a single runner through the cope which is surmounted by a small pouring basin. These basins are 7 inches square and about 2 inches deep. They are rammed up by hand on the top of each mold after it is finished, the sand being held in place by a suitable cast-iron frame which forms the outline of the basin. There is no riser. The molds are set on the floor with their upper ends raised about 6 inches as shown. The flask pins, as previously mentioned, are both on the left side and the right side of each mold is clamped by means of a simple cast-iron hand-grip type of clamp which is wedged over ears cast on the sides of the cope and drag.

FIG. 13—A FLOOR VALVE-BODY MOLDS SHOWING METHOD OF SETTING CORES

The cores are made by hand in hinged type core boxes by men working in pairs at cast-iron benches as illustrated in Fig. 7 which illustrates a half-finished core. An arbor about ¾ inch square runs through the core giving it the necessary rigidity. This arbor also projects about 5 inches at each end, forming convenient handles. The arbors reclaimed from the cleaned castings are carefully straightened and suitably daubed with clay wash before being used again. The vent wire, illustrated in Fig. 7, is withdrawn from the green core as soon as the latter is made, leaving a 3/16-inch vent extending from end to end. The core box is filled and packed by hand. A metal block *P* is embedded in the top half of the core to support the tinned screw *S*, Fig. 9, the function of which has been previously described. A man and a boy make 160 to 170 cores a day. Two pairs of workmen furnish all the cores required for the job. As fast as the green cores are finished they are clay-washed on the gate end and are then set in racks for drying as shown in the background of Fig. 7. Each rack holds 78 cores, 13 in a tier. When the racks are full they are enclosed with temporary sheet metal doors and coke fired from beneath, the cores being sufficiently dried in this manner over night.

The pouring begins immediately after lunch, the iron being brought to the floor in 500-pound buggy ladles running on a track parallel to the molding bays. This track may be seen at the extreme left in Fig. 6. Two-man hand ladles are used for the actual pouring. This operation, together with the shaking out and cleaning up of the floor, is taken care of by a separate gang, the flasks being shaken out so as to leave the sand heap properly arranged for the machine.

No skilled molders are employed and the molding gang consists entirely of apprentices or young men between 17 and 20 years of age. The crew consists of 10 apprentices distributed as follows: One operating the ramming head of the sand-slinging machine; one brushing the patterns and assisting the machine operator; two carrying flasks to the machines; two setting cores; three operating the crane hoist and transferring finished molds from the machine to the floor; and one making the pouring basins and clamping the flasks.

Making each mold involves 11 operations aside from the core making. These operations are as follows: (1) Brush pattern and shake parting over pattern; (2) set flasks on stripping-plate machine table; (3) ram flask either cope or drag as case may be; (4) draw pattern through stripping plate; (5) fit yoke of air hoist to flask; (6) lift flask off machine and turn it over, the copes being turned back after inspecting the mold; (7) set drag on floor with one end raised; (8) set both cores in one operation; (9) set tinned screws on middle of cores as described; (10) set cope in place over drag; (11) make pouring basin and clamp flask.

Economies Realized

Following the methods which have just been described it has been found that with the aid of the sand-slinging molding machine a gang of 10 apprentice boys and two coremakers can turn out from 160 to 175 flasks a day, each containing two castings. The day's work consists of eight hours. When this job was done on a floor by hand, two skilled molders put up 18 to 20 molds a day. The machine does about eight times as much work as a molder and a helper working by hand, with the result that the saving on labor alone is around 50 per cent. After allowing for the fact that the machine crew consists of 10 individuals, and including the cost of power, repairs, depreciation, etc., it is believed that the over-all economy of the machine as compared with hand molding methods is at least 30 per cent in spite of the fact that wages in Scotland are low compared to the United States where the machines were originally developed. The losses by machine molding are little more than with hand molding and it is believed that the castings are more uniform in size and quality. There is no rapping of patterns or hand work on the molds which militate against uniformity. The losses including the strength test to which the castings are subjected, are only about 4 per cent.

The problem of successfully applying the sand-slinging machine to work of this character is really one of traffic management rather than molding, according to Daniel Sharpe, general manager of the Foundry Plant & Machinery Ltd., who points out that the actual producing capacity of the machine itself has seldom been exhausted. In any installation the facilities for handling flasks, pouring, shaking out, etc., are the limiting factors. Therefore, it is advisable in applying the sand-slinging machine, to be lavish with accessory equipment. Such a policy is believed to

prove economical in the general run.

McDowall Steven & Co., Ltd., also use the sand slinging machine for making miscellaneous castings, including valve bodies. Fig. 12 shows one of their two machines rigged up for the production of valves of three different sizes ranging from 2½ inches to 6 inches. Stripping-plate machines are towed behind the sand-throwing machine. A gang of six apprentices can put up from 200 to 250 molds a day according to size. Each mold is provided with a runner and a riser connected to the flanges of the valve. The general arrangement of the work, core setting, etc., is similar to that previously described for telephone-pole bases. A group of valve-body molds, with some of the cores set and with one of the finished castings in the foreground, is shown in Fig. 13. The sand-throwing machine finishes the molds without any accessory ramming and no patching or tinkering is necessary. The production with the machine is from 7 to 10 times that secured previously on this class of work by hand.

The Falkirk Iron Co. operates another prominent foundry in this famous Scotch castings center. In a new shop recently built by this company under the supervision of William Kemp, general manager, a 9-foot tractor-type sand-throwing machine has been installed in a building about 200 feet long. The general arrangement in this installation, which is also being utilized for molding telegraph and telephone pole bases, and other castings, is shown in Fig. 11. As indicated both in the plan and the elevation, a specially designed crane which is towed by the sand-slinging machine, is provided. This crane has a span of 28 feet and a length, between centers of trolley wheels, of 12 feet. The vertical air hoist is carried on a cross trolley which may be readily shifted by hand so as to cover all points on the floor. The crane runway is 10 feet 10 inches above the floor. The crane is coupled to the top of the elevator column of the machine by means of a flexible connection which allows for slight irregularities in the crane runway and machine travel. The Falkirk Iron Co. is now operating three sand-throwing machines.

History of Falkirk District

As suggested in the introduction to this article, the ultramodern methods represented by the sand-slinging machine have been introduced into the Falkirk district against a background of history and tradition unique in iron founding experience. According to Norman Cockburn, chairman of M. Cockburn & Co., through whose courtesy interesting details of the growth of the foundry business in Falkirk have been supplied, the industry in this region goes back to the autumn of 1759. In that year Dr. John Roebuck, an eminent scientist and a friend and associate of James Watt, in partnership with William Cadell of Cockenzie, Scotland, and Samuel Garbett, a wealthy merchant of Birmingham, England, organized a company to manufacture iron on the banks of the river Carron near Falkirk. This firm soon took the name of the Carron Co.

The idea of making iron in this district is understood to have originated with Cadell, who was a ship owner and importer of iron and timber from Russia and Sweden. Iron ore of the type suited to eighteenth century blast furnaces abounded in the valley of the Forth river and its tributaries, and at the time the Carron Co. was organized, the countryside was nothing but a dense forest from which it was presumed an unlimited supply of charcoal could be obtained. It is recorded that when the Carron furnace was first started laborers were available in crowds, hungry and unemployed, able and anxious to work, but without skill or knowledge of what to do. The seams of coal and iron ore were lying almost on the surface on every side and the demand for home-made castings was a growing one. The Carron Co.'s plant was located in its present position by Dr. Roebuck on account of the existence of available water power. Excellent "ironstone," as iron ore is called locally, was found near by in the old coal fields of Borrowstounness, and this discovery was regarded at the time as a sheet anchor for the whole scheme. The Carron furnaces were the first to use ironstone from the Scotch carboniferous formations. This mineral occurs in strata associated with the coal but had never previously been used for iron making. The furnaces were located not so much with reference to the ore as to the fuel supply, in other words the wood supply. The ore was taken to the fuel just as in the United States today. Huge quantities of timber were required for charcoal making and the ancient iron smelters are no doubt largely to blame for the destruction of the old Caledonian forests.

The founders of the Carron Co., it has been pointed out, were not so thoughtless in this respect as their predecessors, as the following extract from a letter dated June 16, 1759 from Mr. Garbett to William Cadell indicates, along with other interesting information:

"Doctor Roebuck and I think Carron Water is a situation infinitely preferable to all others, because if the works prove prosperous as we expect, some places in the neighbourhood of the Firth of Forth will become one of the principal seats of iron works in Britain, not only for making iron from the ore into barrs

(*Concluded on Page* 363)

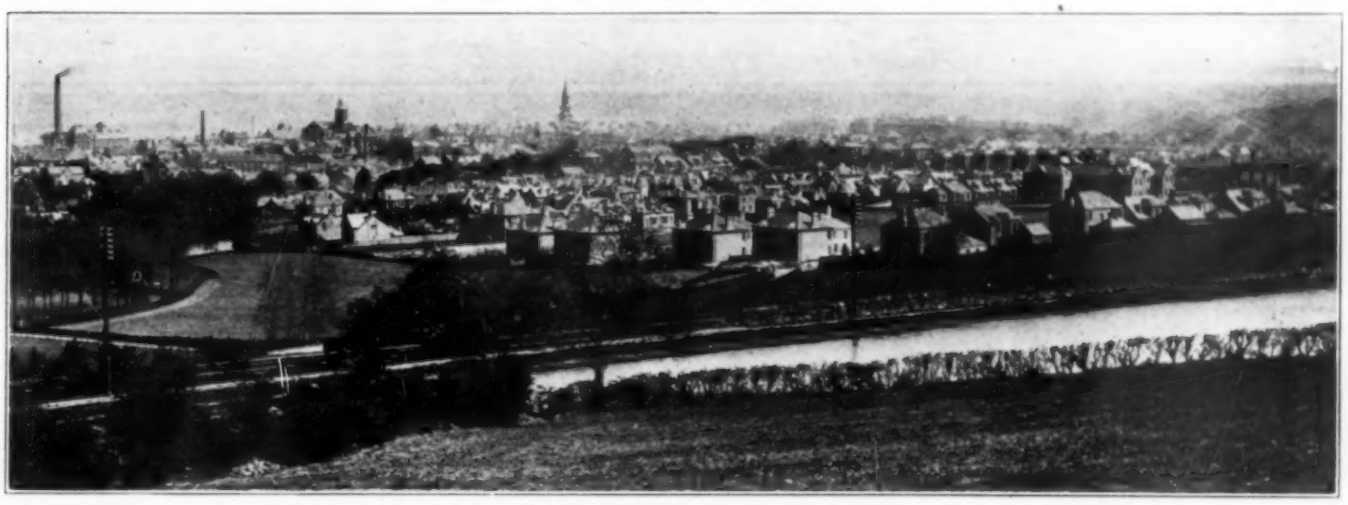


FIG. 14—PANORAMA OF FALKIRK, SCOTLAND, WHERE ALMOST EVERY HOUSE SHELTERS A MOLDER, FOREMAN, FOUNDRY EXPERT, OR PROPRIETOR

Complex Centrifugal Castings

Intricate Hollow Objects Cast in Permanent Molds To Afford Basis of Study—Multiple Axes of Rotation Introduce New Problems in Making Perfect Castings

BY R. L. BINNEY AND N. I. TERBILLE

FOR many years, dating back to a time before the Civil war, centrifugal casting has drawn the attention of various manufacturers and experimenters. It is well known today that cast-iron pipe is being made in this manner and the product so obtained possesses characteristics that are comparable to sand castings.

Other articles also are made by this process and a diversity of metals is employed. In fact, the metal field is well represented in this art. For instance, castings are made by this method in iron, bronze and white alloys. However, the problem that confronted the writers was somewhat unique and after a careful search of the literature and the patents, it was found that little information was available covering centrifugal castings more complex than simple hollow, open end cylinders. The problem faced was difficult and the work done was of such a nature that others will be interested, as undoubtedly many experiments have been made, but not many results made public.

The principle used in casting a pipe for instance, could not be applied directly because in this case only two motions are necessary, namely the rotation of the mold about a single axis. If a cube is cast six sides must be considered, while a pipe might be considered as possessing but four sides, that is in so far as the machine is considered and is analogous to casting a square figure. When it becomes necessary to cast a solid object, the problem becomes much more complex and many difficulties present themselves.

Before starting an attack on the problem, it is necessary to consider factors that are vital to the success of the undertaking. These may be itemized by grouping under the following heads: (1) alloys to be cast; (2) casting temperature of the metal; (3) design and material of the mold; (4) temperature of the molds; (5) methods of introducing metal into the molds; (6) directions of complex rotations; (7) speed of rotations; (8) time of rotations.

Our experiments were confined entirely to the nonferrous field. It is well to note that we chose for our objects to cast, such complex shapes as would present as many difficulties as possible so that results would apply to any object. Elephants, dogs, cows, horses, deer, bears, etc., present not only problems that are met with in casting pipe, where the body of the animal corresponds to the pipe, but these objects present such difficulties as casting long slender legs and peculiar curves that make it difficult to determine the axes of rotation. These objects also required complex rotation to give completely closed, hollow castings.

It was necessary that the metal be strong and in some cases light and in others, heavy. Pure metals such as lead and zinc were tried, but since these elements do not have general application to the industrial field, their success or failure meant little. Therefore, it was necessary to resort to the alloys and different compositions such as antimonial lead and a series of zinc, copper, and aluminum mixtures were tried. The latter, white brasses, have the widest application and therefore are of interest to the mechanical trade.

The casting temperature is of vital importance and it was found that as this was varied, good or bad castings were produced. When the castings are made with centrifugal force, the grain structures are improved, but if the

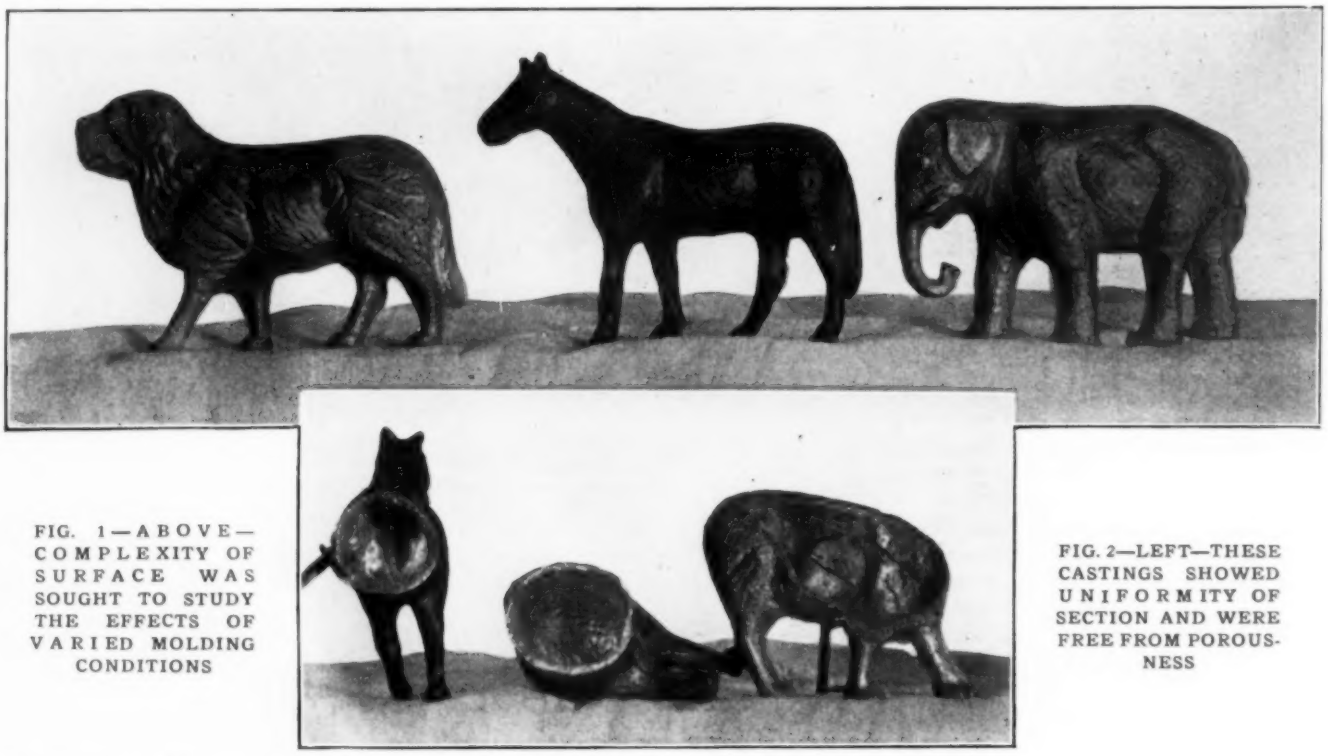
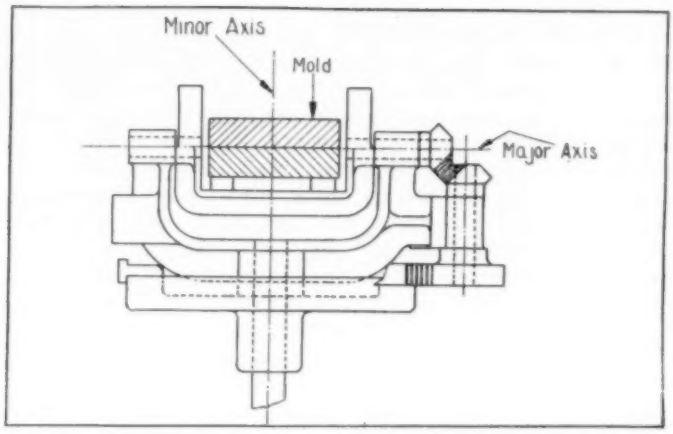


FIG. 1—ABOVE—COMPLEXITY OF SURFACE WAS SOUGHT TO STUDY THE EFFECTS OF VARIED MOLDING CONDITIONS

FIG. 2—LEFT—THESE CASTINGS SHOWED UNIFORMITY OF SECTION AND WERE FREE FROM POROUSNESS



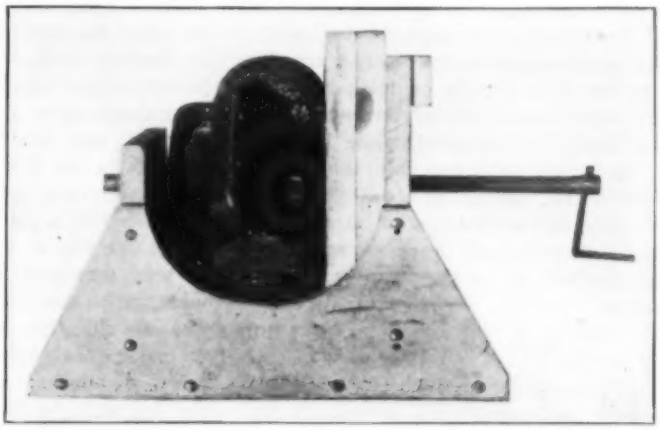


FIG. 3—SIMULTANEOUS ROTATION AROUND TWO DIFFERENT AXES IS REQUIRED FIG. 4—EXPERIMENTAL MACHINE CONSTRUCTED TO STUDY EFFECT OF CENTRIFUGAL FORCE UPON METALS

temperature is incorrect, the walls of the casting are not uniform and the surface defects are multiplied. Cold shuts, air holes, fineness of impression, etc., are influenced by the temperature. The metal must be so gaged as not to freeze too quickly or incomplete castings will result. Metal which is too hot makes the surface imperfect and throws an excess amount to points furthest from the geometric center.

From the nature of the work a permanent or long life mold must be used. This point presents a whole problem in itself and the literature is fairly rich in discussions on this subject. Cast-iron molds, bronze molds, and clay molds present their good as well as bad points. Of course, the nature of the alloy to be cast decides which material may not be used. The cast-iron mold with the proper refractory coating gives good results for most materials. The coating may be so thin, such as a graphite wash, that fine impressions are conveyed to the casting yet the life of the mold is protected by this scanty coating.

Describes Design of Mold

The design of the mold requires someone who is somewhat more than a novice in the art of mold making, because for complex subjects, it is often necessary to have a mold consisting of numerous parts which meet in toggle joints. We were fortunate in securing a man with years of experience and were able to get castings with no fins and still have complex surfaces that are more difficult to make than those usually encountered in industrial work. The mold must be either hinged or fastened in a container to prevent it from opening while in motion and also to prevent it from injuring the complex surfaces where they are joined. Likewise, provision must be made to introduce the metal into the mold when it is in the proper position and still not have a hole from which the metal will be thrown while in motion. Some molds are cast with a core almost perfect and require only a small amount of die work, while others may be made more cheaply by die sinking from a solid piece. Here experience is the best guide. Even an old hand may miscalculate. The mold should be so made that it may be opened quickly and possibly some parts removed from the carriage so as to save time in removing the casting.

Nothing makes scrap faster than incorrect mold temperature. The mold must be so designed that it radiates heat freely or some artificial cooling system will be required. It is possible to have the wall thin enough so that a great deal of the heat is dissipated rapidly. If the mold is too cold, the metal will freeze before the force of rotation has distributed it properly. A hot mold gives varying thickness and causes many surface defects and a poor structure at the surface. Anyone familiar with slush casting will understand readily many of the difficulties and it is well to study the slush casting problems before attempting to cast hollow objects centrifugally. Also, anyone familiar with making molds for slush castings will be able to help with the correct design for this process.

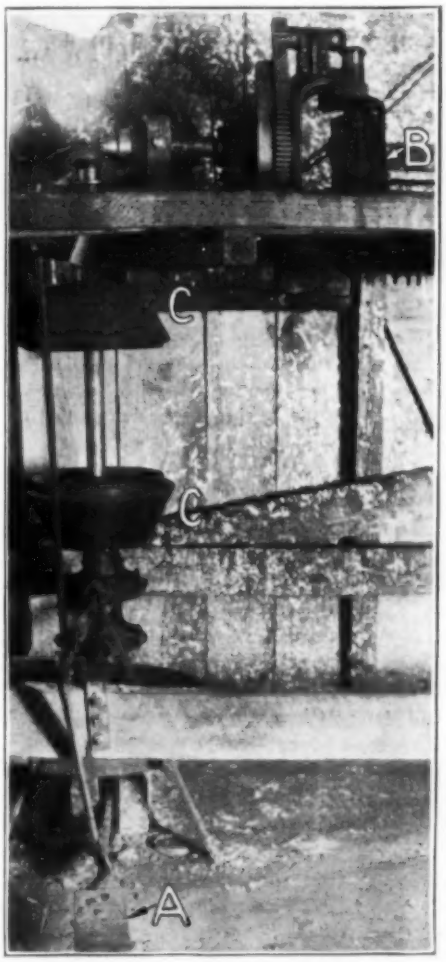


FIG. 5—A POWER DRIVEN CASTING MACHINE HAS GIVEN SATISFACTORY RESULTS

Supplying the Metal

The method of introducing the metal into the mold presents many difficulties and requires considerable experimental work. The mold must be placed in such a position that the metal poured into it will flow into the projections most remote from the center. For example, in the casting of a deer, the position of the mold must be such that the metal when introduced, will flow into and fill the long slender legs. Of course, this is based on the assumption that the metal is introduced while the mold is in the state of rest. When the metal is introduced under these conditions it is necessary to have a device which may be closed instantly, otherwise the metal will begin to set before the machine is started. If the mold is not thrown into motion instantly the possibilities are that only a part of the casting will be formed. If the metal is still hot enough to run after too long a delay in starting the rotation, bad cold shuts will result. It is better for the finished product to introduce the metal while the mold is in motion. A uniform stream must flow gently at a rate that is proportioned to the rate of rotation to get

perfect castings. In both the methods of introducing the metal the problem of the gate is encountered. The metal is introduced at such a point that there is the least chance of it showing. When the metal is introduced while the mold is stationary it is possible to have no gate. The gating problem facing the foundryman working with sand is entirely different and bears no relation to the method of casting described in this article.

Axis Is Important

As pointed out at the beginning of this article, the centrifugal casting of cylindrical parts is much simpler than the casting of complex bodies, because but one axis of rotation is required and such problems as the determining of the major and the minor axes together with the proper speed of rotation about them are not encountered. When a complex body is to be cast, the first step is to determine the major axis of rotation. This is the longer axis and the one about which the speed of rotation is greatest. Even after the axis has been determined from a mathematical standpoint, it has been found that empirical laws exist and it requires slight modifications to get a uniform thickness of wall. The location of the minor axis is a more difficult problem. The point at which the minor axis crosses the major one is not necessarily at a point bisecting it. This does not seem to obey a mathematical law, but is governed by some empirical law that is quite complex and probably not known accurately.

When casting about a single axis, the speed of rotation is important but not as important as when the mold is moving about two separate axes. In the latter case the ratio of the speed about the major axis to that of the minor is most important and when the proportion is not correct, imperfect castings will result. We found that the ratio of the two speeds varied with the objects. For some shapes the speed about the major axis should be twice that around the minor and for other shapes it should be the same. We had cases where the rotation in one direction was five times that in the other. When considered that the location of the axis also influences the ratio and the actual rate of speeds, a glimpse is offered, indicating of how complex is the problem. However, after much work, the writers were able to get intricate castings perfect and plenty strong enough for the required purpose and still only one-fifth the weight of a solid casting.

The time of rotation is not as complex as the other factors governing the work. The chief factor regulating the length of time required is to operate the machine long enough so that the metal has set. Because of the time element in production work, it is best to make the period of operation as short as possible.

In designing a machine for this purpose, it was necessary to construct it so that the mold might be opened easily in the shortest possible time. To accomplish this a carriage was designed to which one side of the mold was attached. It was necessary to construct this so that the hinges would not interfere and also so that the weight be distributed to make a balance with the mold. Here again is another problem that requires the carriage be constructed so that a part of it may be made to move. Thus the carriage will do for all molds of a certain external dimension and still be capable of such adjustment as to control the center of gravity of the rotating member.

When first decided that compound motion was to be used, the simple solid was taken as a basis upon which to construct a machine. A sphere is the natural starting point and the writers assumed that if it were possible to consider a body of molten metal thrown in all directions in a spherical mold a sphere would result. Here two axes of equal length at right angles to each other and in perpendicular planes, both rotating at the same speed would produce a centrifugal force that would throw the metal to the walls of the mold. However, it was not our desire to cast hollow spheres and we chose for our object one not quite as complex as those attempted later. At first the speeds of the two were the same. However, the resulting castings were imperfect and it was necessary to change the ratio of the axes and have a two-to-one effect. Then as different objects were cast this ratio was changed through a change of gears and the location of the axes was changed by changing the position of the mold in the carriage.

Details Plan

The arrangement of the carriage is shown in Fig. 3, the mold being shaded. In this case while it was being rotated in a vertical plane about one axis, it was revolving about the other axis in a horizontal plane. This has the effect of throwing the metal in all directions and causing it to spread over the entire surface of the mold making a complete hollow casting. By noting the sketch it can be seen just how this is accomplished.

The method of starting and stopping the machine are of the utmost importance. In cases where the metal is not introduced during rotation, the mold must start to revolve immediately on closing. The metal must be poured in quickly, the mold closed immediately and rotation started. This was accomplished by friction cones. One cone was constantly revolving and when the mold was closed the cones were engaged by operating a foot lever and then released as the interval of time required for casting is but a few seconds. Numerous adjustments were necessary to enable the machine to serve for many molds. By having the parts slide in grooves and fastened with screws, it is possible to balance molds of various weights and also to change the positions of the axes with comparative ease. Gear changes also must be calculated as the different objects require different speeds. Some safety devices must be designed and it is well to have guards to prevent the molten metal from spilling on the gear teeth or on parts of the machine.

Weight Is Greatly Reduced

It might be well to point out the value of a hollow closed casting. Many objects cast are of such a size that the weight is undesirable where great strength is not essential. Since by our method it is possible to make a serviceable casting of one-fifth the weight of a solid casting, the desired lightness is attained, to say nothing of the fact that one pound of the metal will make five times the amount of the finished product. Here is a great commercial point. Since the metal is cast centrifugally the grain structure is fine, the tensile strength is increased and the resulting casting a great deal stronger than it would be, if it were possible to make it in sand. Further the permanent or long life mold used results in additional economies. One mold will make many thousands of castings in a short time and the accuracy of the castings thus is assured. The working conditions also are improved as the dirt and dust of a normal foundry are absent. If a fairly heavy casting is desired, the method still applies and it is only necessary to increase the amount of metal to give the desired weight.

To illustrate how the experiments were conducted and to show some of the results a few representative castings have been selected. Fig. 4 shows the first machine constructed two and a half years ago. This machine was turned by hand and one wooden wheel rolled on a plane perpendicular to it. By varying the size of the wheels and the distance from the center of the driving member the writers were able to get a series of ratios for speeds about the two axes. In this machine the metal all was poured while the mold was at rest. The mold was fastened to the carriage by a clamp.

While the apparatus was crude, we were able to see possibilities and developed a machine, power driven

through a belt as shown in Fig. 5.

Here the power was transmitted to the carriage proper which was attached to friction cones *C*, *C*, that gave instant motion to the mold. By a system of gears, a series of speeds were obtained. The machine was started by a foot lever, shown at *A*, so that the operator was able to use both hands to set the mold or control the flow of metal. The mold is shown clamped in position at *B*, Fig. 5. The machine had many mechanical improvements in the form of adjustments and metal feeding and was power driven. It was found from this machine that one of the chief features of the design from an operating standpoint was to construct the carriage so that the mold could be opened readily and the casting ejected and allowed to fall on a conveyor that would drop it at the end of the bench where it would cool and be ready for inspection. While the operator was obliged to be on his guard to prevent burns, there was no disagreeable dirt or dust.

Fig. 1 shows some perfect castings that were made in the machine. These weigh one-fifth as much as a solid casting. Here impressions are fine and are accurate, being as close as plus or minus thirty-five thousandths. These figures are shown rather than machine parts because they are so much more difficult to cast. It might be pointed out that they were made in a two-part mold with a toggle joint. At first it was thought impossible, because of the difficult parting line. One mold will make many thousand castings.

Fig. 2 shows the cross section of some of the castings. They are hollow and impervious to water. The thickness of the wall is controlled at will by the operator. The analysis of the metal has something to do with the final result, but the main features are physical, such as the proper temperature control of the mold and metal and the machine adjustments.

Reducing Waste in a Jobbing Foundry

BY W. C. TROUT

ELIMINATION of waste is one of the great problems continually facing the managers of thousands of manufacturing plants throughout the country. Waste is everywhere and although the subject is kept before the foremen and other employes, little progress is made. Apparently the average employe thinks the little things are not worth saving. He takes the attitude that the firm has plenty of money so what difference does it make if a nut or bolt or even a 2-inch twist drill is broken carelessly. He feels that the loss never will be noticed.

This same condition exists in the foundry. Here the belief is found that iron is cheap, so why worry when it is wasted. The employe takes the attitude that it makes no difference if he makes bad casting since the chances are good that it will not be noticed and nothing will be said by the management. Foremen take these things as a matter of course and get so accustomed to the wasteful condition that a big waste of far reaching proportions appears rather small.

The foundry is an old offender in causing waste. Losses in melting now are allowed which may be eliminated to a certain extent by careful charging. The present cupola waste may be lessened by the use of a cinder mill or magnetic separator. However, this method is not employed by all since some think that the value of the recovered iron and coke does not equal the cost of labor, power and the investment on the machines. A few shops offer prizes to employes for eliminating spilling of iron from ladles while they are being transported or during pouring, yet only a small number of employers pay attention to this loss.

However, the greatest loss is in the percentage of defective castings which wastes time, overhead and material. The percentage of loss differs according to the class of work being done. Our own foundry loss, in spite of all we could do last year, was slightly over 10 per cent. Considering the total tonnage, the cost per ton of good castings compared favorably with other foundries of our size.

I have made a particular study of this problem and have questioned many foundrymen on the percentage of bad castings in their shops. One would conclude our showing was poor, judging from the replies received. Many would say "Why ours is not over 2 per cent" and some with a higher regard for veracity report a loss of not over 4 per cent. However, I question if any of those in our section of the country who were asked knew exactly their percentage of loss. In practically every case the answers were approximate. Due to a special class of work our losses were excessive. Outside of this special line, our losses actually were less than 8 per cent. There is a terrific waste in tools and flask equipment that should be kept in mind when it comes to figuring losses.

Consider Only Labor

An old foundryman of my acquaintance used to say when he lost a big casting, "Oh well, we just lost the labor. We'll melt it over again." Many foundrymen still figure on the same basis. All of this leads me to say that if your foundry is 70 per cent efficient, you have a *crackerjack* and few reach this mark. The average is nearer 60 than 70 per cent.

A study of these problems will help your foundry efficiency. However, under the hourly rate system it is hard to increase the efficiency. Thorough supervision and constant attention to these leaks are necessary if progress is to be made, and even then results are far from satisfactory. I thoroughly believe that the foundry is the place to pay only by the piece for good castings. This will not only increase production and reduce costs, but the employe will earn more and be better satisfied.

There is altogether too much waste in the machine shop as well as in the foundry. One seldom hears of a casting having too much stock, but there is a howl when the stock is scant for finishing. This is a waste that always is present and even when reported is not given the immediate attention that it deserves, for not only time but material is wasted. If the castings are machined by the piece no one will rest until the surplus stock is removed from patterns.

We formerly thought the proper way to get machinery parts was to finish as far as possible in the foundry, core everything. I think that this practice has been carried too far. With the high speed gang drills, there is an absolute saving in drilled holes in many classes of work. Other losses could be mentioned but many will say this is simply a matter of management, better and closer supervision, better designing and planning from the management and engineering office down. Yet do we, as executives, give these matters the attention they deserve, or do we leave it to someone else? If we eliminate the losses that we make through management, our employes will learn the lesson sooner. Elimination of waste is going to be accomplished by constant example from the manager down.

The other problem mentioned, that of the advisibility of doing repair work in a manufacturing shop, has been discussed frequently and many are undecided as to the proper course to pursue. Does it pay to take on repair or emergency work in a manufacturing shop? Is there a shop doing this without doing it in a separate department? I do not believe it prac-

From a paper presented at the New Orleans convention of the Southern Metal Trades association. The author, W. C. Trout, is vice president, Lufkin Foundry & Machine Co., Lufkin, Tex.

tical or profitable. When we started our plant nearly 20 years ago, we took in everything offered and the shop slogan was, "No job too large and none too small for our attention." We commenced manufacturing to fill in the time when no repair work was at hand. As I look back over the period of years when the manufacturing business was developing, I believe that we hung to the repair business entirely too long. Although we still are compelled to do some major jobs of repair work, we confine it strictly to repairs on our own line of manufactured articles.

To manufacture machinery and equipment successfully requires a highly standardized plant organization where work may be planned and scheduled to be finished at a definite time and at the lowest possible cost. Unless repair or emergency jobs can be done in a separate department, which seldom is practical, it interferes and breaks up the schedule and entails a serious loss. Repairs should be done in a repair shop where, outside of one or two men, there practically is no overhead and where the wages take into consideration the loss of time when there is no work. On the other hand the owner should get enough to cover idle equipment, loss of tools, etc. There is no question that a strictly repair shop can make money if the volume of business is steady enough and the investment held within reason.

Repair work requires an all around mechanic, who has ingenuity and skill, and this class as a rule is made up of slow workers. Just the opposite type of worker is required for production and manufacturing. The all around man has spent a lifetime getting where he is, while the production man may be trained for his job in a few months. However, working side by side, in his own estimation the production man is worth as much as the skilled mechanic. This results in the shop paying too high wages. Practically it is impossible to do much with the piecework or premium system in a shop that has a large variety of work, and repairing.

A few other points about repair work should be taken into consideration. Much machinery and equipment is so designed that applying new parts brings the machine back to its original standard, so that there is not the repair work there used to be 20 years ago. Further, industrial managers are finding cheap equipment exceedingly expensive. Consequently they buy the best with all parts renewable, and having the best lubricating methods, thus reducing the cost of upkeep and repairs.

The average workman who uses machinery or directs its work has an automobile and knows that to keep it going requires oil and careful usage. This lesson usually results in the careful handling of the equipment of others.

Industrial managers realize more than ever that a worn-out machine is a poor investment, and rather than make repairs the machine is thrown into discard. Sawmills, and many other industrial plants as well, have their own repair shops to care for ordinary work. For these reasons there is much less repair work than there was 20 years ago. However, this still is a problem to us and one which we gradually are solving to our advantage.

Blast Is Too Strong and Causes Bridging

Question: My cupola, lined to 32 inches at the melting zone, practically is parallel all the way down. With three 4-inch diameter tuyeres blowing into one side of the furnace and with a blast pressure of 14 to 15½ inches of water I have melted about 6500 pounds of iron an hour. Recently I carried the windbox all the way around the cupola shell and added two 4¾-inch tuyeres and also increased the size of the original three to the same diameter. The new arrangement gives me a ratio of about 1 to 9 tuyere area to melting zone area and I anticipated securing about 8000 pounds of iron an hour from a fan delivering 2000 cubic feet of air a minute. The coke bed extends 18 inches above the tuyeres and I have been charging 900 pounds of iron, 84 pounds of foundry coke and from 7 to 10 pounds of limestone. Since putting in the new tuyeres I have had considerable trouble. A thick scaffold accumulates at the height of the tuyeres right across the cupola. It becomes thick and strong enough to hold up the stock even after the back has been withdrawn. (English type cupola, solid bottom). Today I expected to melt 6 tons of iron but after 3 tons had melted, the steam stopped completely, the tuyeres turned black and we had to rake out the back with the result that the greater part of the unmelted charge still remains in the cupola supporter on the bridge. Please advise me if there is anything wrong with the tuyere arrangement or with the method of charging. Can you suggest any method for solving the scaffolding problem?

Answer: Your tan capacity of 2000 cubic feet of air a minute is equal to start melting your anticipated 8000 pounds of iron per hour, but to do so you will have to raise your coke bed from 6 to 10 inches, decrease your blast pressure to about 10 ounces and possibly increase the amount of limestone to produce a more fluid slag. Under the old arrangement a comparatively low coke bed (18 inches) was sufficient because the tuyeres were all on one side and therefore the opposite side was not chilled by the blast, but remained hot and finished a passageway for the blast to go up and the iron to come down. Under the new distribution of tuyeres, the blast enters uniformly all around and automatically locates the highest point in the melting zone exactly in the center of the cupola. By flaring the tuyere openings so that practically they touch each other the speed or pressure of the blast entering the cupola will be reduced and at the same time a more even distribution will be secured. It is advisable to provide some means for shutting off individual tuyeres at any time. Frequently during the progress of a long heat the coke in front of some of the tuyeres will become black. If the tuyere at this point is shut off the coke gradually will become bright again and bridging will have been prevented. By alternately shutting off opposite tuyeres for a short time to allow the coke in front of them to burn up brightly it is possible to keep a cupola that size in blast practically all day and then have it drop clean.

Book Review

The Physical and Chemical Foundations of Iron and Steel Works Practice (Die Physikalischen und Chemischen Grundlagen des Eisenhuttenwesens), by Walther Mathesius, professor, Technical High School, Berlin; paper; 483 pages 7 x 9¾ inches; published by Otto Spamer, Leipzig; and furnished by THE FOUNDRY for $10.00 postpaid.

This book, which is published in German, constitutes a complete scientific explanation of the physics, chemistry, and metallurgy of modern iron and steel works practice with special reference to German methods of operation. The author is well qualified owing to his long connection with the German iron and steel industry and engineering development. The book is divided into five parts. The first part, which consists of 119 pages, deals with the physical and chemical substructure of iron and steel manufacture. The second part, 40 pages, covers fuels including coal, coke, coke-oven gas, producer gas, and water gas. The third part, 154 pages, deals with the production of pig iron. The fourth part, 88 pages, covers the production of open-hearth steel, while the final section, 41 pages, deals with the manufacture of iron and steel castings. There is also an appendix giving a large number of sample calculations and mathematical data. The book is prepared in a painstaking manner and contains a large amount of information for those who can read German.

The offices of the Detroit Electric Furnace Co., Detroit, have been moved to 2331 First National Bank building.

Notes Properties of Cast Iron

Manner and Conditions Under Which Graphitization Takes Place in Cast Iron Has Profound Influence Upon Chemical and Physical Properties of the Metal — Describes Special Metal

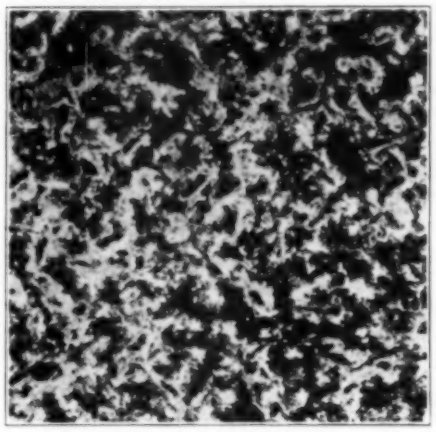
BY ENRIQUE TOUCEDA

IN THE construction of various machines, oil distilling and other apparatus, no metal has proved as satisfactory for certain parts as a strong, close-grained, gray iron. To those following the matter closely, the statement that these parts should consist of a fine grained and strong iron is misleading, except as it indicates two particular requirements that must obtain in the selecting of a gray iron casting for the purpose referred to. It has been found that to obtain the best results the metal, in addition, should possess another characteristic. This other essential, which is the major one, has to do with the character and distribution of the graphite. It is in this particular that a metal made by the Ross-Meehan Foundries, Chattanooga, Tenn., and called Meehanite metal, is of interest.

That the manner and conditions under which graphitization takes place has a profound influence upon the ability of the gray iron product to stand up in service when subjected to certain influences is unquestionable. That the factors controlling graphitization for a predetermined condition and distribution of the graphite is not well understood also is unquestionable. The idea that graphitization can be controlled with certainty by an adjustment of the silicon and sulphur content is far from correct.

Test for Carbon Content

For example, as a rough guide it is the practice in some malleable iron plants to make a 3 x 3 x 8-inch casting slightly notched in the center to facilitate rupture in a green sand mold. The casting is allowed to cool slowly until morning and then the fracture is examined. Through this means an estimate may be made regarding the total carbon content. This has proved a fairly accurate method, provided the silicon and sulphur content of the heats are kept within a rather narrow range. Under these conditions a perfectly white fracture will indicate a certain percentage of carbon, while the extent to which the fracture is mottled, or gray throughout, will indicate increased percentages of carbon directly as the fracture changes from mottled to gray. While this test has given general satisfaction



SHOWS CARBON PRECIPITATED in UNIFORM CONDITION—MAGNIFIES 150 TIMES

in the majority of cases, it has happened at times that the appearance of the fracture has been out of line and misleading. While the fracture would be gray throughout and ordinarily correspond to a carbon content of 2.70-2.80 per cent, an analysis would disclose that it was but 2.20 per cent, the silicon and sulphur being normal. It was apparent that some influence was at work in these instances which served to increase graphitization beyond that justified from a consideration of the white iron composition. The writer believes the influence in question was induced by a bath temperature higher than usual, for the rate of cooling and composition of the test pieces had been practically the same as in those cases in which the fracture showed what the accepted rule had established. The same rate of cooling coupled with a similar silicon, sulphur and carbon content will not at all times produce the same character of fracture, unless the maximum temperature of the bath is similar in both instances.

In the early electric furnace production of white iron castings for the manufacture of malleable iron, many peculiar happenings have been noted. The writer believes these peculiarities owe their explanation to the high temperature attained by the molten metal. However, these are troubles that fortunately no longer exist in the production of castings by this method.

In blast furnace practice certain cases occasionally have been noticed in which the fracture of the pig was completely incompatible with its composition and rate of cooling. In many cases it has been found that in two gray iron castings of practically similar composition, one casting of a considerably higher brinell number will machine with more difficulty than the other in which the brinell number was 50 to 70 points lower. In connection with tool steel, which normally is free from graphite, cases may be cited where this constituent was formed in samples forged under certain conditions. The foregoing has been entered into to point out a fact that is lost sight of with frequency, namely that the conditions governing the precipitation of graphite, its distribution and physical characteristics, is a profoundly complex problem that as yet is far from being understood. It is the writer's thought that there is strong ground for the belief that the temperature to which the bath has been heated plays an important part. Many samples of gray iron of apparently the same composition as that of the samples of the special metal, mentioned which were tested by the writer, have not approximated the tensile or transverse strength shown by the latter, and while the per cent of elongation of this metal is low, this characteristic is absent entirely in the case of other gray iron castings. Whether the temperature of the bath is the factor that operates to cause such differences in mechanical properties, between this metal and others of practically the same composition, or some other influence is at work, the writer does not know.

Presents Complex Problem

The facts already mentioned point out a condition that is lost sight of frequently. Conditions governing the precipitation of graphite, its distribution and characteristics constitute a complex problem that as yet is far from being understood. That temperature plays an important part the writer believes is certain. Whether this is an important factor in the case of this metal must be concluded from the results of the mechanical tests and other data that have been secured from such sources as were available as well as from tests made in the writer's laboratory on specimens

received. The writer believes the first high strength close grained gray iron made was what is called semisteel. In this country the silicon in semisteel runs from about 1.50 to 2.75 per cent and the ultimate strength from about 33,000 pounds per square inch to as high as 45,000 pounds per square inch in exceptional cases. In England where their ordinary gray iron appears to be stronger than that made of similar composition in this country, higher results have been obtained. John Cameron, in an article entitled "Semisteel" in Volume 15 of Journal of the Institute of British Foundrymen, quotes an average ultimate of 40,320 pounds per square inch in the case of 400 bars tested during the manufacture of aerial booms, the record bar going as high as 49,280 pounds per square inch. The average analysis of some 12 of these bars which were ⅝-inch round, was silicon, 2.10; phosphorus, 0.587; sulphur, 0.065; manganese, 0.65; combined carbon, 2.55; graphitic carbon, 0.50.

Compared with Semisteel

In the case of 43 heats of semisteel for propeller wheels the writer obtained an average ultimate strength on bars 1-inch round of 34,249 pounds per square inch, the highest being 37,785 pounds per square inch. The average tensile strength of an equal number of 1-inch diameter bars of semisteel made for valves, was 31,249 pounds per square inch the lowest result being 25,138 and the highest 37,785 pounds per square inch. High tensile close grained air furnace iron has been made by various parties through ferrosilicon additions to a low carbon, fairly low silicon molten metal in the ladle, or air furnace. The writer has records in where ultimate strength varied from 43,000 to in excess of 50,000 pounds per square inch with a silicon content varying from about 2.00 to 2.75 per cent and deflections on transverse test from 3/16 to 7/32-inch failing with loads at center from 4300 to 4600 pounds. No elongations or brinell numbers were recorded.

Air furnace gray iron run down to about 2.50 to 2.65 per cent carbon with a silicon content from 1.75 to 2.25 per cent and with no ferrosilicon additions has been made running from 32,000 to 40,000 pounds per square inch ultimate strength. J. E. Johnson Jr. patented a product which he called oxygenized metal made by partly bessemerizing some cupola metal and adding the oxidized metal to cupola metal not thus treated, by which he obtained a metal in which the graphite was peculiarly distributed. This metal had an average ultimate strength of about 35,000 pounds per square inch.

The writer is not considering gray iron castings made by other processes or by the methods referred to, that owe their mechanical properties and final condition of the graphite to a special heat treatment during solidification or subsequent to it, as he has been informed that the Ross-Meehan company's metal is not a heat treated product.

Bureau Makes Tests

The United States bureau of standards has made a series of tests on this metal comprising 30 impact, 10 tensile and 10 torsional tests. In the impact test the specimens were 0.394 x 0.394 x 2.1 inches with a V-notch at the center of one side 0.079 inches deep and bottom fillet with 0.01-inch radius. The results of this test, which was conducted on a Charpy machine, are as follows:

	Foot pounds energy absorbed
Average of 30 specimens	6.9
Lowest result	4.1
Highest result	11.8

The torsional specimen was 0.5-inch in diameter for a distance greater than 10 inches and had square ends. The results of this test is as follows:

	Extreme fiber stress pounds per square inch	Total twist degrees
Average 10 specimens	55,100	43.6
Lowest result	44,800	27.8
Highest result	63,300	55.8

In the tensile and hardness tests the specimens were about 0.5 inches in diameter with a gage length of 2 inches and with threads screwing into adaptors having spherical bearings. The results are as follows:

	Ultimate strength pounds per square inch	Per cent elongation in 2 inches	Brinell hardness number
Average of 10 tests	50,500	0.4	290
Lowest result	45,300	0.0	269
Highest result	56,500	1.0	324

Two specimens of this metal were sent to the Lucey Mfg. Corp., New York, for testing. The results of the tests are shown in the following tables:

Tensile Test

Diameter inches	Area square inches	Ultimate load, pounds	Elongation
0.505	0.1965	8050	None
0.505	0.1965	9860	None

Transverse Test

Diameter inches	Neutral distance inches	Mending moment pounds	Breaking load, pounds
1.25	0.75	17,500	7,000
1.25	0.75	10,500	7,800

Ultimate Tensile Strength

No. 1	40,950 pounds per square inch
No. 2	50,000 pounds per square inch

	Moment of Inertia	Extreme Fiber Stress
No. 1	0.2488	52,500 pounds per square inch
No. 2	0.2488	58,500 pounds per square inch

Several years ago at the start of the development of this metal, about 45 bars were sent to the writer with the request that he submit the results of the tensile test. The resutls of the tensile test were as follows:

	Ultimate strength pounds per square inch
Average results	48,900
Lowest result	35,620
Highest result	56,500

Average Brinell hardness 258

The following will indicate the improvement that has taken place since the tests were made:

No.	Area	Tensile strength pounds per square inch
1	192	60,000
2	192	54,200
3	193	60,700
4	192	56,800
5	192	59,700
6	194	53,400

The modulus of rupture of ordinary gray iron is in the vicinity of 12,000,000 pounds per square inch. The modulus of rupture of this metal averages about 23,000,000 pounds per square inch while that of semisteel lies between these two figures. On the six bars tested in this laboratory the following breaking loads and deflections were obtained:

Diameter of bar, inches	Distance between supports, inches	Ultimate load, pounds	Deflection at failure, inches
1.31	12	5,500	0.10
1.34	12	6,200	0.13
1.32	12	6,600	0.14
1.32	12	5,700	0.13
1.33	12	5,500	0.13
1.33	12	6,240	0.13

A further indication of the progress that has been made can be gathered from a comparison of the early transverse tests with those recently made by the Lucey Mfg. Corp. When it is considered that the American Society for Testing Materials specifications call for a transverse strength on the arbitration bar of not under 2500 pounds for light, 2900 pounds for medium and 3300 pounds for heavy castings, with a deflection of not less than 0.10, it is clear that this metal excels these requirements particularly when these results are considered together with the deflections. While it is the opinion of many engineers that the softest irons yield the highest deflections on transverse test the contrary is true. Even with a silicon content as high as 3.30 per cent, the carbon is precipitated in a uniform condition as will be noted from the accompanying reproduction of a micrograph taken at a magnification of 150.

Satisfactory service has resulted from this metal when used for ammonia machinery, for acid handling castings in certain industries, for hardened gears, etc. It has been found adapted for use in piston rings, boiler castings, pump and automobile cylinders, high pressure valves, air compressor castings, valve and cylinder packing rings, valve chamber and knuckle pin bushings in locomotive construction and in oil refinery apparatus where porosity of any kind is fatal and acid and heat resisting properties are essential. Good results have followed its use in the lower trays of tower stills which are subjected to a high temperature and pressure and to considerable weight from above.

Three units for the manufacture of products under the supervision of the Colby Management Corp., Los

Angeles, will be constructed at Monrovia, Cal., by the Union Iron Works. The first unit will be 100 x 300 feet, saw tooth type, steel frame construction, and will house the foundry. The old foundry facilities of the Colby corporation will be moved into the new plant. The second unit will be the machine shop and the third the assembling plant. The Colby corporation is a holding and management company for various industrial companies among which are the Vacuum Street Cleaner Mfg. Co., Southern California Truck Owners' association, Kimball Motors Corp., Industrial Finance & Mortgage Co., etc. The present location of the plant is at Huntington Park.

Determine Sulphur Content in Iron

BY LEON J. WISE AND L. H. RUDESILL

THE determination of sulphur in iron and steel by the evolution method has been the subject of much criticism by chemists throughout the industry due to the tendency of the results to run low, especially in irons of high sulphur content. The method, as commonly used today, is essentially as follows:

A definite weight of sample drillings, or powder, is introduced into a dry 500 c. c. erlenmeyer flask fitted with a two-hole rubber stopper containing a thistle tube and an exit tube. To this is connected a glass delivery tube leading into a second 500 c. c. erlenmeyer flask containing the absorbent. Dilute hydrochloric acid (1-1) is added through the thistle tube and the sulphur in the sample is liberated as H_2S. The H_2S thus liberated is converted into a solid sulphide by conducting it through a suitable absorbent. The precipitated sulphide is subsequently dissolved in hydrochloric acid and the regenerated H_2S is titrated with a standard iodine solution, using a starch indicator, to the appearance of a blue color.

This method yields fairly concordant results for plain carbon steels and irons of low-sulphur content, but when the sulphur content is over 0.10 per cent variations in duplicate analyses frequently are large.

One factor which probably contributes more to the inaccuracy of the results than any other is the fact that when the cadmium sulphide is dissolved in hydrochloric acid, just before the titration with iodine, some of the H_2S liberated escapes before the titration is begun, regardless of how careful the analyst is to prevent agitation. Also, during the titration, if vigorous stirring is resorted to, some H_2S will escape, while on the other hand it is almost impossible to dissolve all the CdS from a high sulphur iron without stirring vigorously.

It was with the end in view of eliminating this difficulty that the following method was tried. Solutions were made as follows:

Hydrochloric acid solution —1000 c. c. conc. HCl+1000 c. c. water.

Iodine solution—3.75 grams KIO_3+ 18.75 grams KI+0.5 grams NaOH in 3000 c. c. water.

Sodium thiosulphate solution—20 grams $Na_2S_2O_3$ plus 1 gram NaOH in 2500 c. c. water.

Cadmium chloride-starch solution—85 grams $CdCl_2$+10 grams soluble starch dissolved in 1000 c. c. water and added to a solution of 1800 c. c. NH_4OH in 1800 c. c. water.

The iodine and thiosulphate solutions are made equivalent by titrating one against the other in an acid solution with starch indicator, determining the ratio of the two solutions, and diluting the stronger with the correct amount of water to make them equivalent.

The iodine solution was first standardized against a standard 60-mesh sample of white cast-iron containing 0.050 per cent sulphur, as follows:

A 5-gram sample was weighed into a dry 500 c. c. erlenmeyer flask which was closed with a two-hole rubber stopper containing a thistle tube and an exit tube to which was connected a delivery tube leading into a second 500 c. c. flask containing 200 c. c. water and 25 c. c. of the cadmium chloride-starch solution. The delivery tube was arranged to extend to the bottom of the absorbing solution so that the gas had to bubble up through it.

Eighty cubic centimeters of the HCl solution was then added through the thistle tube. Bubbles of evolved gas immediately began to appear in the absorbent. It bubbled rapidly at first but soon slowed down. When the first violent action of the acid subsided a gentle heat was applied to the evolution flask, taking care not to allow the mixture to boil until the solution of the iron was complete, as evidenced by a cessation in the flow of the gas through the absorbing solution. At this time the heat under the evolution flask was increased until the solution began to boil, in order to drive out the last traces of H_2S. Care was taken not to allow the steam to enter the absorption flask as the hot acid vapors woud destroy the alkalinity of the absorbent and might entail a loss of H_2S.

When all the H_2S was expelled from the evolution flask the delivery tube was disconnected from the exit tube of the evolution flask. It was necessary to do this before removing the source of heat in order to prevent a back suction of the absorbent. The delivery tube was allowed to remain in the absorption flask.

Then 10.0 c. c. of the iodine solution was run into the absorption flask from a burette, and 40 c. c. of HCl solution was added, all precipitate adhering to the delivery tube being washed into the flask and the delivery tube removed. The flask was then shaken vigorously for several minutes.

The function of the HCl here is two fold. It disolves the cadmium sulphide thus regenerating the H_2S:

$$6\ HCl + 3\ CdS = 3\ H_2S + 3\ CdCl_2$$

and also liberates the iodine in a form to react with the H_2S:

$$3\ HCl + 5\ KI + KIO_3 = 3\ I_2 + 3\ KOH + 3\ KCl$$

The liberated H_2S then unites with the liberated iodine as follows:

$$3H_2S + 3I_2 = 6\ HI + 3\ S$$

It is obvious that by having an excess of iodine solution present in the flask when the HCl is added to dissolve the CdS the danger of loss of H_2S due to agitation is eliminated because the iodine is in the solution to react with the H_2S as soon as it is liberated.

The excess of iodine over and above that required to react with the H_2S gave the solution a dark blue color. Standard sodium thiosulphate solution was run in from a burette until one drop caused the blue color to just disappear. The number of c. c. of thiosulphate subtracted from 10.0 gave the cubic centimeters of iodine used by the H_2S, since the solutions were made equivalent. The sulphur content of the iron divided by the number of cubic centimeters of iodine used gave the sulphur value for 1 c. c. of iodine solution for a 5-gram sample of iron. On six samples the iodine solution varied from 4.9 to 5.2 c. c. with an average of 5.0 c. c. The sulphur content (0.050 per cent) divided by the number of cubic centimeters of iodine used (5.0) gave a sulphur value of 0.010 per cent for each cubic centimeter of iodine required for a 5-gram sample.

Tests were then made by this method using an excess of iodine and titrating back with sodium thiosulphate, and by direct titration as outlined at the begin-

ning of this article. The iron sample C of the U. S. bureau of standards, which is reported to contain 0.05 per cent sulphur gave the following results when tested:

Analysis Number	Per Cent Sulphur Found: Addition of excess iodine	Direct Titration
1	0.050	0.040
2	0.049	0.046
3	0.052	0.046
4	0.049	0.042
5	0.051	0.043
6	0.050	0.046
Average	0.050	0.044

Similar results were obtained using different samples of the bureau of standards iron samples ranging in sulphur content from 0.038 per cent to 0.103 per cent. When using the new method we consistently checked the sulphur content within 0.001 or 0.002 per cent, while with the old method the results were from 0.003 to 0.010 per cent low, the error being greater in the irons of higher sulphur content.

It is therefore concluded that by having an excess of iodine present when the H_2S is liberated for titration the main source of error is eliminated. That is, it is possible to shake the solution vigorously to dissolve the CdS without danger of any H_2S escaping, and the results consequently running low.

Erratic Cupola Practice Causes Trouble

Question: Our cupola is lined to 27 inches and although we usually have enough work on the floor to require 3000 pounds of iron, we have to stop pouring after we have tapped between 2000 and 2200 pounds. Slag appears at this point and the iron is too dull to pour. The inside of the cupola is daubed with new molding sand and the bottom is made up with about three 10-quart pails of sand from the floor. Paper and wood are placed on the sand followed by 5 bushels of coke and then the fire is lighted. About 10 or 15 minutes later 3 additional bushels of coke are dumped in and 2 more are added after another 15 minutes. Sufficient pig iron and scrap are charged to fill the furnace about half full. This is followed by 2 bushels of coke and then the stack is filled to the charging door with pig iron and scrap. The fan is started about 1½ hours after the fire has been lighted and when the charge begins to sink, iron and coke are charged in the proportion of 1 bushel of coke to 500 pounds of iron. We shall appreciate your advise on what to do to remedy the trouble.

Answer: Briefly your trouble is due to the fact that you are not using enough coke to produce hot iron on the latter part of your heat. Coke from various ovens varies in weight and may weigh anywhere from 35 to 50 pounds to the bushel. A ratio of 1 to 10 is considered high for a small cupola and therefore even if your coke weighed the maximum of 50 pounds to the bushel you would be doing better than the average. In all probability your coke does not weigh over 40 pounds to the bushel and that means that you are not using enough to maintain your bed at the proper height. You do not state the height or number of tuyeres and therefore we cannot say definitely whether or not 10 bushels of coke is the correct amount of the bed. From your statement that the first iron comes down in 10 minutes we are led to assume that the amount is approximately correct. However instead of speculating on what you probably are or are not doing we shall outline briefly what you should do to secure satisfactory melting conditions.

Ordinary molding sand, particularly the kind employed in shops making light work, is not sufficiently refractory for cupola lining. It contains to high a percentage of clay bond and melts down in the shape of a thick slag. Where the coke contains little ash, where the iron is clean and where the charges are properly proportioned and where the heat does not run over one hour, a sand lining may cause no trouble. However, all these favorable conditions rarely obtain at the same time. A coke high in ash, dirty iron, a high blast or an insufficient quantity of coke between the charges will cause the slag to build out rapidly from the sides of the cupola and choke it. The remedy is to employ a fire clay daubing or molding sand to which a considerable quantity of sharp sand has been added.

The coke bed should extend about 30 inches above the tuyeres at the time charging commences. Mark this point before putting up your bottom doors and then bend a long rod in the form of a capital *Z*. One toe of the rod will rest on the charging door sill and the other toe will correspond with the mark on the cupola wall. Place about three-fourths of the required amount of coke on the wood and light the fire. When this has burned through add sufficient coke to bring it up to the mark. Charge 500 pounds of iron, then sufficient coke to form a layer at least 4 inches thick. Place 500 pounds of iron on top of this and continue charging in this manner until the entire amount for the day has been charged. If the iron shows a tendency to become cold, increase the amount of coke slightly each day until the correct amount has been determined. Usually the fan may be started one hour after the fire is lighted but if the cupola is allowed to stand longer than one hour, the first iron will come down in a shorter time.

Traces Early History of Gray Iron Castings

John D. Miller, superintendent of foundries, the Cresson-Morris Co., Philadelphia, addressed the Philadelphia Foundrymen's association at its April meeting. He traced the development of gray iron castings from an early date, describing a crude furnace constructed in Pennsylvania in 1720. This furnace required 180 bushels of charcoal to melt a ton of iron. He said the first cupola was operated in 1820 and that 1830 probably represents the real start of the gray iron foundry business. Mr. Miller presented interesting data on technical phases of gray iron castings and called attention to the growth of the industry in the past few years.

Publishes Bulletin

A recent quarterly bulletin issued by the council of the British Cast Iron Research association is prefaced by Dr. Cecil H. Desch, professor of metallurgy, University of Sheffield, and deals with the work accomplished in assisting foundrymen to overcome the many difficulties which beset them. It calls attention to the need for investigations and research covering fundamental principles underlying the whole foundry industry.

A number of interesting articles are included in this bulletin covering foundry sand and clays giving the effect of iron oxide on the bonding property of molding sand; coke and its behavior in the foundry; cupola practice including the design of cupola; the volumetric determination of sulphur in pig iron; the persulphate, arsenite and sodium bismuthate methods for the determination of manganese in pig iron, etc.

Numerous abstracts are given from current foundry literature covering cast gray and malleable iron, molding sand, cupola practice, fuels, general refractories, foundry cost keeping, corrosion, and general foundry practice.

Information of value to foundrymen is given under the heading of "Practical Foundry Data" and deals with a wide range of diversified subject such as steel additions and shrinkage, malleable iron mixtures for air furnace, tinning and welding gray cast iron, melting ratios, cupola losses, etc.

H. H. Valiquet has been made chief engineer of the Kirk & Blum Mfg. Co., Cincinnati, maker of dust collecting and pneumatic, conveying and ventilating equipment. Mr. Valiquet formerly was connected with the Chicago division of the B. F. Sturtevant Co., Boston.

Action of Lead Upon Alloys

Discussion of the Obstacles Which Have To Be Overcome in the Melting and Production of Satisfactory Castings from Alloys Suitable for Use in Mine Pumps and Accessories

BY GEORGE A. DRYSDALE

IN DEALING with nonferrous alloys in general, a practical knowledge of the fundamental principles involved in mixing, melting, and casting such alloys is essential from a metallurgical standpoint, before the results obtained are uniform and satisfactory. For with such metals and alloys, the physical and resistive properties are controlled almost entirely by the methods employed and the conditions under which they are produced. This applies to mixing and melting the elements to form alloys; their melting temperatures; the methods of pouring; the structural formation or crystallization on cooling or solidifying in the mold; the contraction, shrinkage, segregation, etc., all of which are important factors.

The chief difficulty in melting, mixing and casting leaded bronzes, where the percentage of lead runs to 10 per cent and over, is the natural tendency of the lead to segregate from copper and tin.

Use of Leaded Bronzes

Leaded bronzes are used extensively for pumps and other accessories for mine use due to their high resistance to the corrosive action of mine waters. As lead is one of the most satisfactory base metals known at the present time for such purposes, it is becoming more generally used in the manufacture of pumps and such accessories as piping, valves, etc. The following are a few of the mixtures used or specified for acid resisting metals for this purpose:

Copper	Tin	Lead
80	10	10
75	10	15
65	10	25

Such combinations commonly are referred to as leaded bronzes, and heretofore the great difficulty experienced in producing them satisfactorily, was that of segregation of the lead in combination with copper and tin. In consequence of this difficulty, a general knowledge of the action of lead when used in combination with other metals, and more especially with copper and tin, is essential. A practical knowledge of the chemical and physical properties of the metals used must include the alloying of such metals, as to whether they form chemical compounds, binary alloys not compounds, or just mixtures. Consider the following for example:

1—Copper and tin form a definite compound and become a solid solution of tin and copper.

2—Tin and lead do not form a compound of solid solutions, but mix in all proportions forming a series of true alloys.

3—Copper and tin with lead do not form a true alloy for the fact that lead separates out, on cooling in the mold, in the form of globules, and the copper and tin unite to form a binary alloy. This assertion must be modified by the instance where the lead content is not over 0.25 per cent, when such a condition is not apparent.

With the foregoing explanation for a mixture of copper, tin and lead, it is essential that great care be exercised in melting, and mixing and casting such an alloy. The copper first should be brought into a molten state, using either pots or furnaces, and the tin and lead added to the molten mass at as low a temperature as possible, to avoid excessive oxidation of the tin, and lead. In other words, the more infusible metals are melted first and the more fusible, added to the molten mass, or dissolved in the former. This mixture should be stirred thoroughly and poured into pigs, for the reason previously explained: that the lead separates out in distinct globules throughout the mass. For this reason also, the more stirring or mixing given the molten metal, the more evenly will the lead be distributed. The pigs of this alloy then should be remelted, stirred and poured into molds, thus producing more uniform castings.

Segregation in Castings

Because of the segregation of the lead in alloys of this combination, it is natural to assume that the physical properties of the alloy relatively will be reduced as to the tensile strength, yield point, elongation and reduction in area, in proportion to the lead content. Therefore, such a mixture must be as nearly homogeneous as possible, judged by its fracture, and free from segregation, or the castings made of such a mixture cannot comply with reasonable specifications calling for water pressure tests, and acid resisting properties in the case of mine pumps and accessories.

In the first instance water under pressure will have a tendency to seep through any segregated parts of the casting and in a majority of cases, cannot be overcome by the usual piening process. In the second instance, the segregated parts are attacked more readily by acidulous water and the life of a pump in which such a casting has been used, will be greatly reduced.

Acid Resisting Properties

At the present time the study of acid resisting metals and alloys is one of great importance with the bureau of mines and the American Mining congress and a number of scientific societies and for this reason experimental work is being carried on in the effort to solve such problems. It has been found that lead, and lead base alloys (over 50 per cent of lead) are the most highly resistant of cast metals to the action of acidulous mine water. Copper and nickel base alloys are considered not as highly resistant, and consequently unsatisfactory when considering the life of a mine pump handling such waters. Due to their softness and low physical properties, lead and lead base alloys have not been used extensively up to the present time, for such purposes. The copper and nickel base with only small percentages of lead, although less resistant, are in common use because of their good physical properties.

Now metallurgists are considering the production of lead base alloys for mine pumps, owing to the superior resisting qualities in handling highly acidulous mine waters. The term acidulous means more than the word implies, as recent research work has proved that there is a greater percentage of total acidity than the free sulphuric acid present. Sulphur alone had been considered previously. Consequently the service conditions are more severe than previously estimated.

Therefore, it is desirable to obtain the resistive properties of lead, to alloy or mix with it other elements to give certain physical properties. It is along these lines that the writer has been experimenting for a number of years endeavoring to produce such an alloy to resist the corrosive action of mine waters and have the physical properties of strong cast iron. This research work has established the far reaching effects

of small proportions of other elements upon the physical and acid resisting properties of such alloys.

Previously attention has been given principally to lead base bearing alloys, and although much valuable work has been done along these lines, the major point of consideration has been the hard and soft matrix formed.

The following are a few of the lead mixtures suggested for mine pumps castings:

Lead	Tin	Antimony	Copper	Nickel
90	5	5	..	..
90	..	10	..	..
75	8	15	2	..
70	10	10	3	7

Difficulty has been experienced in producing satisfactory castings from these mixtures. They can be used only when the melter has a thorough knowledge of the physical properties of such mixtures, of the metals entering into the combinations, and the formation of chemical compounds, alloys and mixtures. The writer noted the following conditions:

Lead and tin do not form chemical compounds or solid solutions, but mix in all proportions to form a series of binary alloys.

Lead and antimony do not form chemical compounds or solid solutions, but produce simple series of alloys. Such a combination can be used only in small proportions with satisfactory results.

In alloys composed of lead, tin and antimony, the only compound formed is that of tin and antimony.

Alloys of lead, tin and antimony are similar to those of lead and antimony, but due to the solubility of the compound of tin and antimony, the addition of tin diminishes the hardness. Further such a combination must be used in definite proportions. In alloys of copper and tin containing lead in large quantities, the lead does not alloy with the copper, but separates in the form of globules. Consequently, in dealing with the mixing, melting and pouring of copper and tin, or of tin and lead, no difficulty will be experienced with segregation in the castings, but with the mixture of copper, tin and lead, segregation will prove an obstacle.

In alloying metals of widely different melting points, the melting point of the resultant alloy is much lower than that of the most refractory metal. In a number of instances it is slightly above the melting point of the least refractory metal. For example, nickel may be alloyed in a bath of copper, and copper may be alloyed in a bath of tin at a much lower melting point than the nickel or copper alone. The proportion in which the different metals are used to form alloys materially affects the melting point of the alloys. The following tabulation illustrates the effect on these alloys:

Per cent copper	Per cent nickel	Approximate melting point degrees Cent.	degrees Fahr.
75	25	1100	2021
50	50	1250	2282
25	75	1400	2552
	Pure	1450	2642
Pure		961	1760
	Monel Metal	1360	2480

In dealing with a lead base alloy, composed of lead, tin, antimony, copper and nickel, the copper and nickel should be alloyed first, added to the molten mass of lead, tin and antimony. This is essential in overcoming the tendency for excessive oxidation of the metals of lower melting points, such as lead, tin and antimony.

In casting nonferrous metals either in green or dry sand molds, a knowledge of the melting points, gravity, time of solidification, or set, etc., are essential as they relatively control the product. The best methods of procedure are as follows:

Base Metal	Pour	Time of solidification	Risers
Lead	Light	Slow	Light
Copper	Medium	Medium	Medium
Nickel	Heavy	Rapid	Heavy

Another of the difficulties experienced in casting lead base alloys is the burning in, or sweating of the lead into the cores, which is the cause of a great deal of trouble in the cleaning room. Often air hammers have to be used in separating the core from the casting. This is expensive. Such a condition is overcome to a great extent by using a fine molding sand with sharp sand in making up the core. The proportion of the molding sand used, and corresponding density of the core should vary with the per cent of lead in the mixture and the weight of the casting. An example of a mixture for core work, for a lead base metal carrying over 70 per cent of lead, is as follows:

2 parts sharp sand
1 part fine molding sand
Usual core oil—with silica wash

Such a combination has been used successfully for cores in molds where the casting weighed over 1000 pounds. The cores easily were extracted from the casting leaving a clean smooth inner surface.

How and Why in Brass Founding

By Charles Vickers

Defects in Bearings Come from Wide Sources

We are having considerable difficulty with a heavy bearing we are casting. The metal thickness of the back is about 2 inches and the flanges are ¾ and 1 inch respectively. We are sending you a section cut from a broken casting to show the fracture of the metal, also the shrinkage difficulty, which you will note is internal and fails to show on the outside of the casting. The casting is made bearing downward, and the hollow is shaped like an arch, its top lying a ¼-inch below the outer surface of the back of the casting and it is a curved, jagged opening varying in width from 3/16 to a ¼-inch at the top and tapering to nothing at the ends. The fracture of the metal also is mixed, copper colored and brown with a matrix of gray. Can you tell us how to eliminate this trouble? Can we use the material over again without running into the same trouble? We are using all old metal, and about how much new copper do you feel it would take to get the best possible results? The melting is carried out in a non-crucible furnace, oil-fired.

Any answer that can be rendered to the questions asked in the light of present knowledge will be merely guess work, and one persons guess is as good as another. Thus I will guess the shrinkage is due to pouring too cool and with too low a head of metal and too small a feeder. This guess is based on the theory that this peculiar shrinkage formed in the heart of the metal is natural in origin, but if it is, then it is unique, for shrinkage would most naturally take the form of a hollow on the outside of the casting. It is evident the metal had considerable time to solidify before the change took place that resulted in the formation of this internal hollow. Its presence gives rise to the suspicion that the casting was uncovered too soon. The cope was lifted while the metal was hot and tender and the flanges binding in the sand carried a part of the casting upward. Then as bleeding was noted from the joint, the cope was hastily dropped again and the two parts being

soft, welded together. The large discolored spots extending from the cavity and immediately under it, was caused by the penetration of steam or water. Of course, the latter at that temperature immediately would turn to steam. However, the metal is bad. The alloy is not properly balanced, being made of scrap. There was no control over the composition and the result is a heterogenous mixture that solidifies into a mixture of different alloys, hence the different colors of the fracture, outside of the area discolored by steam. The addition of certain deoxidizers or combinations of deoxidizers will produce this condition even in normal alloys. To write with authority and certainty regarding this condition, it would be necessary to make a careful investigation, assisted by chemical analysis, micrographs, and by a complete knowledge of the method of casting the mold, and gating it. This would cost considerable money, and would require time, but it is utterly impossible to give any intelligent idea of how much copper to add to the mixture without an analysis. In the absence of this knowledge all is guesswork.

Casting Bronze Collars Around Steel

We have contracted to cast bronze collars around several hundred mild steel drop forgings. We would appreciate any suggestions you may offer that will aid successful foundry operations.

There are two prominent causes of failure when casting bronze around iron or steel objects. One is blowholes, the other is cracking of the bronze, and both of them are avoided by exactly the same treatment of the iron or steel; namely, heating it. The steel or iron should be heated until it would burn the fingers if touched, but it should be kept below the temperature that would cause it to oxidize, because oxide itself will cause a blow in the bronze.

The steel, or iron must be clean, but hot and no trouble will result. These two requirements can not be too highly emphasized; clean and hot. We can understand why it is desirable to have anything clean, whether hot or cold, but why hot? Because if the iron or steel is cold the chances are in favor it will be cooler than the sand of the mold. The mold contains water, constantly evaporating, and this moisture will condense on anything cool. The cool iron is just the thing, so it gets covered with dew drops, and when the molten bronze enters that mold and is received by a piece of iron covered with dew drops, can we blame it for feeling insulted. Bronze is touchy about moisture on anything hard, whether iron or a baked sand surface like a core. When the insert is hot, hotter than the sand of the mold, it keeps dry. Therefore, leave the molds open, heat the iron, insert just before pouring and all will be well.

Iron expands when heated. If the bronze expands the iron as it enfolds it, the iron expands as the bronze shrinks. The result is a crack in the bronze. For heavy castings, arrange a flow-off for the bronze.

Pressure Castings

We are making valve castings for oil wells and experience difficulty getting them to withstand the pressures, which for deep work sometimes reaches 2000 pounds. We have tried red brass, phosphor bronze, and copper 90 per cent, tin 10 per cent and in each case they have leaked under pressure. We melt in an oil-fired crucible furnace, and have been very careful in molding and melting but without success.

Two alloys much used for pressure castings are the following:

PRESSURE CASTING ALLOY—I

	Per cent
Copper	82.00
Tin	7.50
Zinc	4.75
Lead	5.75

PRESSURE CASTING ALLOY—II

	Per cent
Copper	83.00
Tin	11.50
Zinc	4.00
Lead	1.50

An alloy having a very close grain is wanted. It also must be free from oxide inclusions, in which connection the presence of even traces of aluminum appears very injurious. With the high tin alloys there is danger of liquation and the tin as a rich alloy with copper oozes out after the casting has solidified. The presence of phosphorus assists this liquation. Therefore, it is advisable to use some other deoxidizer than phosphorus for high tin alloys. A good deoxidizer is iron. In fact, iron if chemically combined with the rest of the alloy would be very helpful to any pressure alloy. When chemically combined the castings will be dark colored externally. If they are orange-colored the iron is not combined but will be found as nodules which will break the machinist's tools. If the 90-10 alloy had been deoxidized by the use of a flux that adds iron, it would have been more likely to have withstood the pressure. Such a flux is the following: Yellow prussiate of potash 1 pound; white sand 1 pound, soda ash 1 pound, calcined borax 3 ounces. Mix thoroughly, and use for one hundred pounds of metal, tie in paper, drop on the surface, leave ten minutes then cautiously stir into the metal.

Casting Aluminum Alloy

We are casting knife handles of aluminum alloy, and from an inspection of the samples we send, you will note the presence of pit holes on the outside, some of the pits appear to be caused by grains of sand, others by shrinkage under ribs and bosses. We mold them from a pattern plate in a 12 x 16 inch flask, and pour with two sprues connected to two separate runners which feed 12 patterns each, making 24 patterns in each mold. The outside of the handle is cast in the drag half. Would casting the outside of the handle in the cope eliminate the pits? We use one-half pure aluminum, with one-half scrap crankcases, and find it necessary to pour at between 1400 to 1500 degrees Fahr. to run the castings. We have also tried all new metal of No. 12 alloy with the same results.

The question to decide is whether it is better to take the loss from this source, or to slow up production by taking greater care to clean the molds of loose grains. The irregular cavities that follow the crystal boundaries are not so easily dealt with. The castings are only 1/16 inch thick, and the boss and ribs are very small. Therefore, it does not appear reasonable to credit these defects to shrinkage of the metal, especially as they appear on the side exposed to the sand of the nowel. The metal has to be poured hot, between 1400 and 1500 degrees being too hot for aluminum alloy. The hotter the metal is poured the greater the difficulty of getting it to lay quietly against the surface of the mold and if it does not, there will be defects on the surface of the castings. The difficulty arises from the molds, the hot metal makes steam which keeps the aluminum quivering until it solidifies. Watch the sprues after pouring. The problem is to make a mold against which the metal will lie quietly. Soft ramming of the nowel is helpful, as is dusting them with a fine powder such as parting which acts as a blotter. There is a possibility that casting the backs in the cope would be helpful as it is easier for steam to rise than to go down also there is no escape for it in the nowel, the bottom boards provide against that. It is worth a trial, but the runner will have to be raised into the cope. Be very careful about ramming nowels with heated sand. In addition to the foregoing steam generated from heated sand causes the sand to stick to the pattern.

Density Indicates Soundness

Analysis Shows Composition While Density Determines Condition of the Casting —Results Obtained by Former Investigators Given and New Method for Determining Density Is Outlined

BY T. G. BAMFORD

DENSITY or *mass per unit volume has for a long time been* accepted as one of the physical constants and, as such its values have been obtained for a large number of elements, compounds, and mechanical mixtures.

However, investigators have largely confined their attentions to determinations of the densities of fluids, and this is owing to the fact that the various physical constants of a fluid are functions of the state of the fluid at the moment, while in solids that is not in general the case. Ordinarily solids such as the metals and alloys will show varying specific properties, but the values of such properties will be governed entirely by composition, condition, and previous history. A sample of 70:30 brass, for example, will have a density that is dependent upon the casting conditions, precise composition, mechanical and thermal treatment to which it has been subjected, and upon the prevailing environmental conditions.

Determine Density of Metals

The determination of the density of metals and alloys may be carried out rapidly, and with a fair degree of accuracy, in the laboratory, and could therefore more generally be used as an aid to deciding whether they have received satisfactory treatment at each stage of manufacture.

After casting a brass billet an analysis will decide whether the required composition has been attained, and a density determination should indicate whether correct casting conditions have been observed and, in fact, whether a sound casting has been obtained. Unfortunately, no accepted standard figures are available to which the densities of particular alloys cast under specified conditions should conform. It is hoped that the present paper will supply this practical demand for information in the case of the copper-zinc series.

In 1842 R. Mallet* published data respecting the alloys of copper and zinc, in which was included a table of specific gravities of twenty-one alloys of different compositions. However, no information is available regarding methods adopted in casting these alloys, and the results obtained are so irregular as to be almost worthless. Whereas some regularity is observable at the copper-rich end of the series, the results are entirely erratic for all alloys containing more than 50 per cent zinc, the gravities rising and falling sharply six times in passing from the range of composition 50 per cent zinc to that of 25 per cent zinc.

In 1859 F. Grace Calvert and R. Johnson† published a paper upon the properties of certain alloys, and submitted density values for nine different copper-zinc alloys. They give no details concerning methods of casting. Their results are plotted in Fig. 1, and it has been possible to construct a smooth curve which would pass close to seven of the nine points. For comparative purposes in this case, and in all cases hereafter mentioned, the theoretical density curve (assuming no expansion or contraction due to the alloying) has been plotted alongside the actual curves obtained by the various experimentors.

In 1873 A. Riche‡ also cast a number of these alloys, and he is the first research worker who records any information as to experimental methods. Sixty to one hundred gram ingots of each alloy were cast in the same mold. While no definite statement is made, a reader of Riche's paper would infer that he used a cylindrical iron mold, as he states precisely that he did so in certain tests on bronze alloys. We are not told that any analyses of the alloys were carried out, but since he makes use of the term *actual composition* we must assume that some form of analytical control was adopted in the experiments. Riche made determinations first upon the ingots as cast and then upon extremely fine filings taken, respectively, from the top and bottom of each ingot. His results obtained are plotted in Fig. 2. Fairly consistent values are obtained in the first series of results within the range 90 per cent to 35 per cent copper, but outside that range so few figures are available as to render interpolation valueless. In the second series differences of as much as 0.14 exist between the density of the top and bottom of the casting, but sometimes the top sample, and in other cases the bottom sample, has the higher value. The mean results are therefore plotted and are very irregular.

Boils Samples in Water

In 1901 E. Maey * made new determinations of the density of the copper-zinc alloys, particularly with the hope of establishing the existence of chemical compounds between the elements copper and zinc. He melted small 10-gram samples of pure copper and zinc in small covered porcelain crucibles and allowed the alloy to solidify in the crucible. Allowance for loss of zinc by volatilization was made when weighing out the sample, but no analysis was made of each alloy as a check upon its composition. The samples were subjected to prolonged boiling in water prior to each density determination, in order to avoid the existence of air spaces, which according to Maey may be completely filled with water by this treatment. He concludes that the detection of

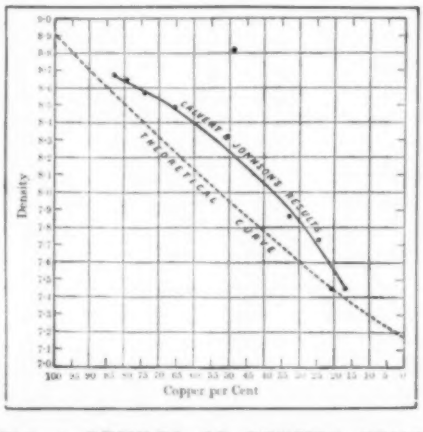


FIG. 1—RESULTS OF DENSITY TESTS MADE BY CALVERT AND JOHNSON

*Philosophical Magazine, 1842 (3rd Series), vol. xxi, p. 68.

Paper presented at the meeting of the British Institute of Metals held in Birmingham, England.

†Ibid., 1859 (4th Series), vol. xviii, p. 354.
‡Annale de Chimie et de Physique, 1873, Series (4), vol. xxx.

*Zeitschrift fur physikalische Chemie, 1901, vol. xxxviii, p. 295.

chemical compounds is masked by the presence of solid solutions and cannot, therefore, be made by density or specific volume determinations but must be done by other methods.

Recently Rudolf H. Weber,* in investigating the magnetic susceptibility of the copper-zinc alloys, had occasion to obtain their specific gravities. He made two series of determinations. In the first, zinc was heated to the melting point, and small portions of pure copper, mixed with ammonium chloride, were added thereto. The temperature was maintained not higher than the melting point of each alloy. In the second series, copper was melted under borax and the zinc added. The temperature was raised considerably above the melting point.

In all cases small Berlin porcelain crucibles were used, and the mold consisted of sand bound together with china clay. No attempt was made to ensure the obtaining of sound castings, as Weber specifically states that casting faults do not influence his magnetic measurements. His second series of results are plotted in Fig. 3.

Only two investigators, Riche and Weber, have analyzed the alloys used in the density determinations. All made small castings; none record agreement of duplicate determinations on different samples cut from the same casting; and none, apparently, adopted any special precautions to ensure that the samples were sound.

It is true that Riche made determinations, using powder filed from the top and bottom of each sample, but his results are not concordant. It is also true that Maey endeavored to avoid the effects of porosity by boiling his samples in water; but this, if successful, would at once render the results useless to the practical man who wants to know what density an ordinary sound specimen of given composition should have, if cast successfully under given conditions. He further wishes to know if, for example, a chilled specimen should have a different density from one cooled slowly, and what should be the values in each case.

*Journal of the Institute of Metals, No. 2, 1909, vol. ii, p. 99.

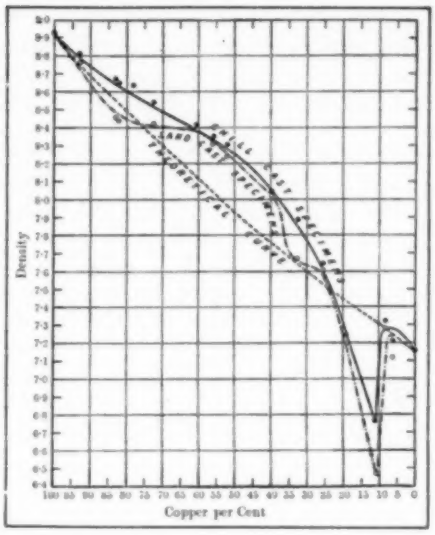


FIG. 4—RESULTS OF DENSITY TESTS MADE BY WEBER—SECOND SERIES

Experiments Made Recently

Mr. J. H. Teng, working in Professor Turner's laboratory at Birmingham university, during the years 1917-18, upon the alloys of zinc and aluminium, found that both sand and chill castings had density values throughout which were lower than postulated by theory if no volume changes occurred when the two metals were alloyed. He found, however, that in all cases the chill-cast specimens had higher values than the sand-cast specimens.

In no published data is there any attemp to differentiate between the density of chilled and of sand-cast specimens. Weber is the only research worker on the copper-zinc series who tells us that he used a sand-mold, and Riche leads us to believe that chill-molds were adopted.

In the present investigation both chill and sand-cast billets of a cylindrical shape, 12 inches long and 1 inch diameter, were poured from each heat and comparative values of the density obtained. The weights of the billets varied from 2 pounds 8 ounces to 3 pounds 1 ounce, according to composition.

The chill-mold was of the ordinary split cannon type made in cast iron. The sand-mold was made up in ordinary loam molds. Cathode plate copper and commercial zinc were used.

The heats were melted in open salamander pots in coke fires under borax. It was not possible to record the temperatures, but in all cases a pouring temperature was used which would result in a sound casting. After casting, the outside skin of each billet was turned down in a lathe for distance of about an eighth of an inch. If the metal did not appear to be perfectly sound, the experiment was discontinued and fresh castings were made until sound ingots were obtained. The turnings were used for analysis. The composition of the billets was found to be uniform throughout.

If either chill or sand casting were

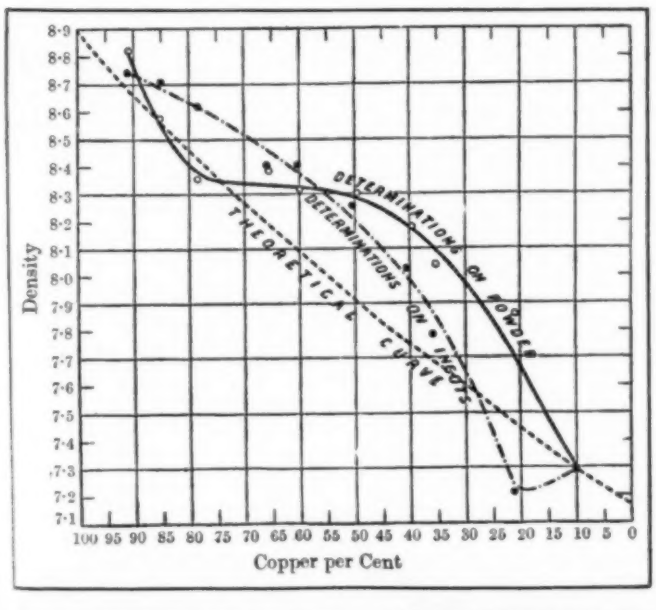


FIG. 2—RESULTS OF DENSITY TESTS MADE BY RICHE ON THE COPPER-ZINC ALLOYS IN INGOT AND POWDER FORM

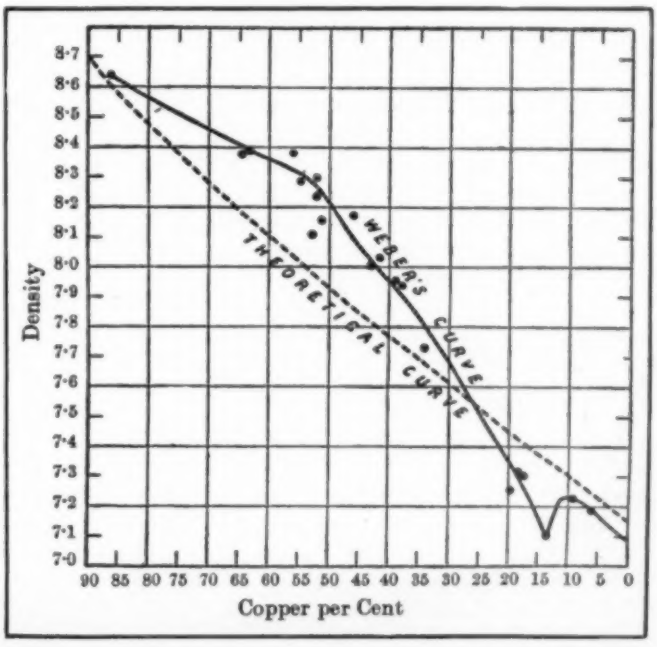


FIG. 3—RESULTS OF DENSITY TESTS MADE BY WEBER

unsound the two samples were rejected, but it should be mentioned that the sand casting was usually the more difficult to obtain quite sound.

Cylindrical samples weighing 30 to 60 grammes were prepared for the density determinations by turning down in the lathe, cutting off about 10 cubic centimeters from the bottom of the casting, and polishing with smooth files and French emery papers. The samples were weighed in air and in redistilled and boiled water. Suspension of the samples from the balance was effected by means of a small platinum stirrup. The stirrup itself was always submerged in water up to fixed mark when determining the weight of a sample in water.

The volume of the stirrup up to this mark was determined by weighing it in air and in water. An error would be introduced due to surface tension, but the same error would occur not only in weighing in air but also in taking the weights of all the samples in water. Therefore, it will readily be understood, that surface tension effect would not influence the density results. No allowance was made for the density of the air, as the influence of this factor would be less than the limit of accuracy permitted by other factors. The temperature of the water at the time of each observation was, of course, noted and taken into consideration in all calculations. The densities were taken at 18 degree Cent., referred to water at 4 degree Cent. as 1.000.

Results Agree Closely

The degree of accuracy was such that separate determinations upon the same sample, at different times, would agree to less than 0.005 absolute value. Agreement between separate samples cut from the same bar could be obtained to less than 0.02 absolute value. It might be argued that this is not a high degree of accuracy, but it was found that a sound sample differed from an unsound specimen by as much as 0.38.

The results obtained are plotted in Fig. 4, on which curve the results obtained with sand and with chilled castings are both shown.

Those points obtained by F. Grace Calvert, which are consistent among themselves, also agree closely with the results of the chill-cast determinations made by the author.

Riche's results obtained upon the ingots, agree within the range of composition 90 per cent to 35 per cent copper remarkably well with the author's chill-cast results. Below 35 per cent copper Riche's results, as previously stated, are insufficient, but indicate a rapid fall in density value in this range.

With Maey, the author confesses that he can discern agreement only within a small range of composition, and it can only be suggested that this is due to the fact that no analysis was carried out and also to Maey's *modus operandi*, in which he boils his specimens in water prior to each density determination.

With Weber's results, as might be anticipated, no close concordance is obtained.

Referring now to the author's results in detail, it may be noted that with one exception, namely, 60.7 per cent copper, the densities of the sand-cast specimens are less than those of chill-cast ones, and that in this exceptional case the two densities differ by less than the limit of experimental error.

The two curves run side by side with points of close proximity at 40 per cent copper and 24 per cent copper. They have maximum divergence at about 83 per cent copper, 50 per cent copper, and 35 per cent copper.

Former Investigations Confirmed

In the entire region extending from pure copper down to 30 per cent zinc, a net contraction has taken place due to alloying and solidification of the two metals. This is revealed by both curves, except for a small part of the sand-cast curve, as they are above the theoretical density curve. However, below 30 per cent zinc, a marked expansion takes place, culminating in minimum density value at 12 per cent copper.

The results fall into line with Shepherd's curve for the copper-zinc series, and also afford remarkable confirmation of the data published by Turner and Murray * on the volume changes of the copper-zinc alloys, establishing the fact that the changes recorded therein were actual volume changes and were not caused merely by thrust or by longitudinal movement, as had been suggested might be the case.

The points at 61 per cent copper and 40 per cent copper correspond closely with the points *A* and *B* on Shepherd's diagram, and also with the points at which Turner and Murray † record a zero expansion upon solidification.

Points of maximum divergence between the curves for chill and sand castings, which occur at 83 per cent and 50 per cent copper, correspond to points of maximum divergence between liquidus and solidus on Shepherd's curve and to points of maximum expansion recorded by Turner and Murray.

When the liquidus and solidus curves come together as they do at the points *A* and *B* on Shepherd's curve, the alloy would have a uniform composition whether slowly cooled or chilled. When, on the other hand, we are dealing with an alloy corresponding to a composition at which liquidus and solidus are widely different, quick chilling from the molten state may produce a cored, heterogeneous structure, as is in fact well known to be the case with chill-cast brasses having a copper content above 65 per cent copper. In such a case the last crystals to form may constitute a phase which would not have formed at all under conditions of slow cooling.

It is to be anticipated, therefore, that, while alloys corresponding to the points *A* and *B* would have equal density values whether chill or sand cast, alloys having other compositions would have a different metallographical structure, and therefore different density values according to their rate of cooling after having been poured into the mold. The agreement between these theoretical considerations and the actual results indicates, the authors believe, a confirmation of the accuracy of the results.

The equilibrium diagram of alloys whose compositions contain less than 30 per cent copper is so complicated that it is difficult to draw parallels between the density curves and the equilibrium diagram. Some new factor appears which causes a remarkable expansion and affords striking confirmation of the expansion recorded by Turner and Murray. Samples in this region have been prepared which turn easily in the lathe and appear perfectly sound, but which may be caused to absorb large quantities of water by prolonged immersion therein. We are evidently dealing here with a new form of porosity different from ordinary unsoundness.

*Zeitschrift fur physikalische Chemie, 1901, vol. xxxviii. p. 295.

†Ibid., No. 2, 1909, vol. ii. p. 115.

Buys Large Furnace

The United States navy department has purchased a large high frequency induction furnace from the Ajax Electrothermic Corp., Trenton, N. J. The contract calls for one furnace capable of melting 200 pounds of steel, one furnace for melting 500 pounds of brass or copper and four smaller furnaces. The electrical equipment is rated at 140 kilovolt amperes, and it is said will put more high frequency power into each of the furnaces than has been employed in any such furnace previously. The next largest furnaces melt 100 pounds of steel each at the plant of the Western Electric Co., Chicago. Each of these furnaces is rated at 105 kilovolt amperes.

The name of the Orangeville Agricultural Works, Orangeville, Pa., has been changed to the Orangeville Mfg. Co. The same management will continue.

Cleaning Automobile Castings

Careful Inspection and Cleaning Room Treatment Required—After Tumbling and Sandblasting, the Castings Are Sent to the Grinding Department—Plant Makes Aluminum Crankcases

BY B. K. PRICE

RAPID and efficient methods are essential in the cleaning room of a foundry devoted to the production of automobile castings. Owing to the exacting nature of the work, the methods followed at these plants are of interest. At the Brunswick, N. J., plant of the International Motors Co., the foundry output averages approximately 45 tons per day. Twenty-five tons are gray iron, fifteen aluminum and five bronze. The castings produced are of light section and they vary in weight from a few to 350 pounds.

With the exception of some of the larger units, the first step in cleaning gray iron castings consists of tumbling. The castings are sorted carefully as to weight and design to preclude the possibility of light parts being damaged in the rattling process by the action of the heavier ones. Four tumblers of the company's own design are installed. These are hexagonal in form and hold about seven tons each. A fifth tumbler of approximately 15 tons capacity will be installed in the near future to accommodate heavy gray iron castings ranging up to 250 pounds in weight. Castings that cannot be tumbled readily are cleaned by sandblasting in a cabinet, equipped with a rotary table, as shown in Fig. 4. The principal iron castings to be subjected to this operation are exhaust and intake manifolds. In this operation a special effort is made to go over the exterior surfaces thoroughly to impart to the castings a frosted finish. Flint is used for finishing both cast iron and aluminum. Fig. 4 illustrates a sandblasting operation on a crankcase. Bronze castings are not sandblasted. Following the sandblasting operation the castings are subjected to a close inspection. The gates and sprues then are chipped or sheared off as the case may demand. Next the castings are conveyed to the grinding department. Some of the smaller castings, however, do not follow this course of procedure, as they are merely filed.

The grinding shop illustrated in Fig. 1 is equipped with 14 double grinders. As the castings usually are not large and as comparatively few flat surfaces require grinding, hand grinders are used in preference to swing-frame machines. Fig. 5 shows an exhaust manifold in the process of grinding and this illustration gives a general idea of the class of work on which these grinders are used. As Fig. 5 shows, the grinder is suspended from a coil spring which imparts flexibility and supports the device so that the operator does not have to handle the grinder as a deadweight unit.

The wheels on the floor grinders are operated at a peripheral travel of approximately 5000 feet per minute. As they wear down they are remounted on machines of a higher speed rating so that the desired peripheral travel can be maintained practically constant. Some of the machines, however, are equipped with a differential belting system by which the spindle speed can be increased as the wheels wear away. These grinders accommodate wheels 16 inches in diameter, two-inch face. The hand grinders are equipped with eight-inch wheels. Fig. 3 illustrates a section of the general cleaning room where most of the chipping and filing is done. In some instances small castings are filed in preference to grinding.

The aluminum output is confined mostly to crankcases. The first step in finishing them is to chip off the gates

FIG. 1—THE GRINING MACHINES ARE FITTED WITH AN EXHAUST SYSTEM TO CARRY AWAY THE ABRASIVE DUST

Fig. 2.—Above—Crankcases Are Sprayed To Determine Defects in Casting—Fig. 4—Right — Crank cases Are Cleaned by Sandblasting — Fig. 5—Below—Small Castings are Snagged by Hand Grinders

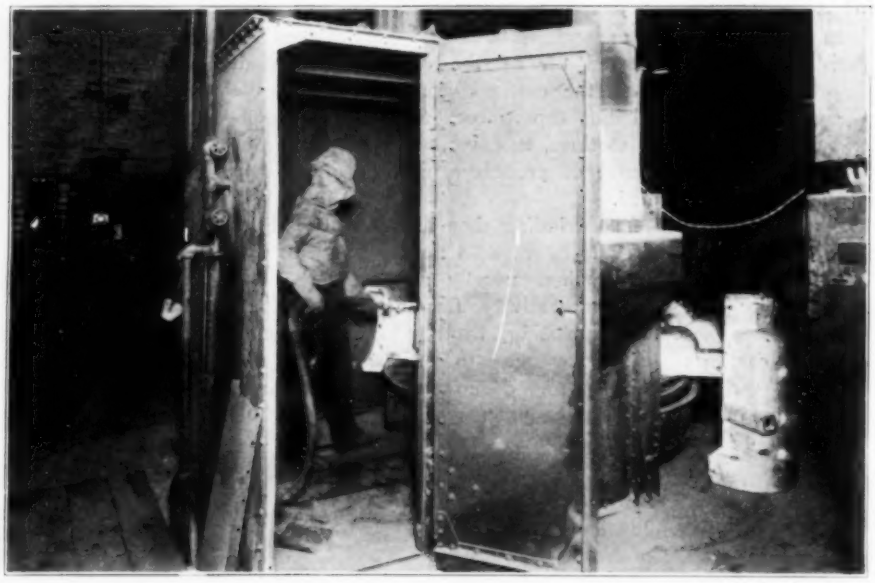
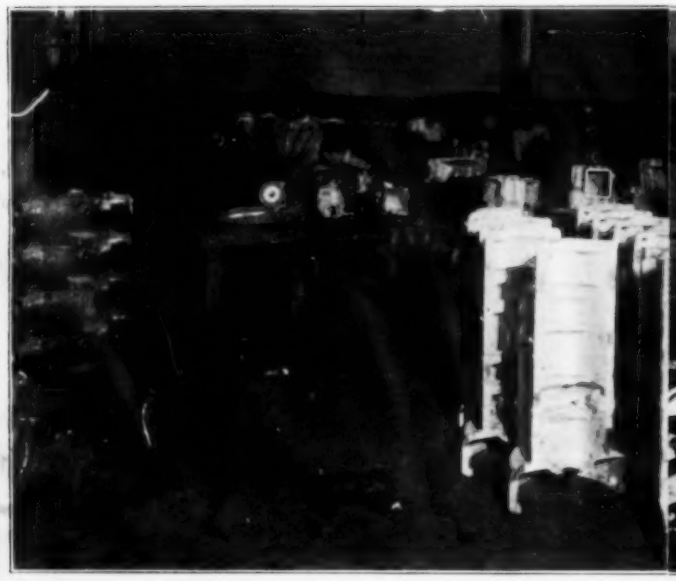


Fig. 4—Above—Small Castings Are Sometimes Snagged by Filing—Fig. 6.—Below—Welding Operations Sometimes are Necessary on Expensive Castings



Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

PROPERTIES OF SPECIAL WELDING RODS

General

The data here presented are the result of investigation by the committee of the American Welding Society and is offered solely as a guide for the selection of welding material of the nature described, and must not be considered a direct recommendation as investigations have not been completed which would permit the preparation of specifications for this class of material.

This is a broad field for research and plans are being developed whereby each class of material will be definitely recommended as determined.

Nomenclature

In referring to folio, the analysis prefixed by the letter G indicates the material is intended for gas welding.

Chemical Composition

The chemical composition shall be within the following limits for the uses specified:

Medium Carbon Steel

The data show that welding rods having a carbon content ranging from 0.06 to 0.60 are of no particular value.

HIGH CARBON STEEL

Carbon	0.60—0.75	of one per cent
Manganese	0.60—0.90	of one per cent
Phosphorus	not over 0.04	of one per cent
Sulphur	not over 0.04	of one per cent

Physical Properties

Rods shall be made of annealed commercially straight wire of uniform homogeneous structure, free from irregularities in surface hardness, segregation, oxides, pipe, seams, etc. Diameter shall not vary more than plus or minus 3 per cent from diameter specified.

Surface Finish

The surface shall be smooth and free from scale, rust, oil or grease, and may be plain or copper coated.

Recommended Sizes

1/16, 3/32, 1/4 inch diameters.

Uses

For welding high carbon steel and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary, such as—rails, frogs, switch points, bearing surfaces, etc.

NICKEL STEEL

Nickel	3.25—3.75	per cent
Carbon	0.15—0.25	of one per cent
Manganese	0.50—0.80	of one per cent
Phosphorus	not over 0.04	of one per cent
Sulphur	not over 0.04	of one per cent

Standard Specifications of the American Welding Society.

(*Continued on Data Sheet No.* 524)

PROPERTIES OF SPECIAL WELDING RODS

(*Continued from Data Sheet No.* 523)

Physical Properties

Rods shall be made of annealed commercially straight wire of uniform homogeneous structure, free from irregularities in surface hardness, segregation, oxides, pipe seams, etc. Diameter shall not vary more than plus or minus 3 per cent from diameter specified.

Surface Finish

The surface shall be smooth and free from scale, rust, oil or grease, and may be plain or copper coated.

Recommended Sizes

1/16, 3/32, 1/4, 5/16, 3/8 inch diameters.

Uses

For welding mild steel, producing, however, a weld of greater strength but a lower ductility than secured with G-No. 1A in standard welding rod specifications.

CAST IRON

Silicon	3.00—3.50	per cent
Carbon	3.00—3.50	per cent
Manganese	0.50—0.75	of one per cent
Phosphorus	0.50—0.70	of one per cent
Sulphur	0.10	of one per cent

Physical Properties

Rods shall be commercially straight, of either round, hexagonal or other regular shape.

Surface Finish

The surface shall be cleaned and free from sand, dirt or scale.

Recommended Sizes

3/16, 1/4, 3/8 and 1/2, and in 12 to 18 inch lengths.

Uses

For general welding of cast iron parts.

Tests

Rods when broken shall show a uniform grain of gray cast iron structure.

YELLOW BRASS

Copper	60.0—70.0	per cent
Zinc	30.0—40.0	per cent
Iron	not over 0.06	of one per cent
Other elements	not over 0.10	of one per cent

Material

Cast or drawn.

Physical Properties

Rods shall be straight and of homogeneous structure.

Surface Finish

The surface shall be smooth and clean.

Recommended Sizes

1/16, 1/8, 3/16 and 1/4 inch diameters.

Uses

For brazing.

(*Continued on Data Sheet No.* 525)

LONG DISTANCE TELEPHONE
Main 3616

CABLE ADDRESS
"SIMPSON" CHICAGO

NATIONAL ENGINEERING COMPANY

Specialties
SIMPSON INTENSIVE FOUNDRY MIXER
SIMPSON NATIONAL SCREEN SEPARATOR
SIMPSON BUCKET LOADER
SIMPSON SAND HANDLING EQUIPMENT
FOUNDRY APPLIANCES

Manufacturers & Engineers

Machinery Hall Building, 549 W. Washington Blvd.
CHICAGO, ILLINOIS, U.S.A.

H. S. SIMPSON, PRES.
J. L. SIMPSON, V-PRES.
A. L. SCOTT, TREAS.
E. M. STANEK, SECY

May. 29th, 1923

The Foundry,
Penton Building,
Cleveland, Ohio

Gentlemen: Attn: Mr. J. D. Pease, Director Advertising Sales

During the past few months we have had very good evidence of the value of advertising our SIMPSON SAND MIXER and SIMPSON BUCKET LOADER in the "Foundry".

Your representative in this section, Mr. Pelott, probably has no client who so quickly recognizes the advantages of a page ad, which we have carried, twice a month, for a number of years, than ourselves. It affords us great pleasure to indicate that we consider that investment one of the most profitable we have ever made.

Our idea on advertising is to allow the user of our SIMPSON SAND MIXER to know that the machine is still in a class by itself. In other words, we believe that advertising is as important for the users of the machine as it is for prospective customers.

While of course the success of our SIMPSON MIXER is mainly attributable to the merit of the machine itself, we can honestly advise you that the "Foundry" has had a large share in the practically universal use of our machine in so many foundries, making all kinds of castings.

With very best wishes for your continued success, we are

Yours very truly,

NATIONAL ENGINEERING COMPANY

H S Simpson

President

HSS:MR

FIG. 7—GENERAL VIEW OF THE CHIPPING DEPARTMENT IN THE FOUNDRY MAKING AUTOMOBILE PARTS

and risers as shown in Fig. 7. They then are sent to the sandblast machine and from that department to the grinding room. Subsequent machining operations on these castings are performed at the company's plant at Plainfield, N. J.

An interesting test on aluminum crankcases is illustrated in Fig. 2. Here the outside surfaces are sprayed with a mixture of *xylol* and *calcimine*. This mixture dries readily. The operation is concluded by standing the crankcases on end and spraying the interior with plain *xylol*. If blowholes or other imperfections are present they are readily discovered by the *xylol* seeping through and leaving a mark on the casting exterior.

Cast iron manifolds are subjected to a hydraulic test with water at a pressure of 80 pounds to the square inch. If welding is necessary it is performed by the oxyacetylene process. Part of the department where this operation is performed is shown in Fig. 6. Welding is used chiefly on expensive castings.

The greater portion of the bronze production represents bushings on which the only cleaning operation is tumbling. Such parts as shifter forks, etc., are snagged, tumbled and filed. The company also operates an extensive precision grinding department where various units entering into automobile construction are finished.

Refractories Used in Aluminum Melting

BY ROBERT J. ANDERSON

SO FAR as can be learned, the question of refractories for use in the aluminum industry has been neglected considerably, but this matter is of the greatest importance to the producers of primary aluminum and to manufacturers who melt aluminum and aluminum alloys. The question of refractories for use in the aluminum industry will be discussed only briefly here, but refractory makers can get further information as to the needs and requirements of users by consulting with the nonferrous metals section of the United States bureau of mines. In taking up discussion of the subject here, it is convenient to discuss refractories for use in melting substantially pure aluminum, and refractories for use in melting aluminum alloys.

Refractories for use in aluminum and aluminum-alloy melting furnaces should be considered as refractories for the setting of the furnace itself, and as refractories to be used as the containing vessel or in a hearth with which the aluminum or aluminum alloys are in contact. Also it should be pointed out that while the temperatures employed for melting aluminum and aluminum alloys are relatively low, usually under 800 degrees Cent., the corrosive action of liquid aluminum and its light alloys is great. Therefore, refractories usually fail in aluminum melting (where the liquid metal is in contact with the refractory) by corrosion, or eating away of the refractory.

Referring first to the production of primary aluminum by electrolytic reduction, the material used for the furnace linings is carbon, such as petroleum coke or gas carbon. In making a furnace for aluminum reduction, a steel shell is lined first with any suitable refractory which has low thermal and electrical conductivity, and within this lining a layer of rammed lining of petroleum coke is placed. The problem of obtaining a good lining for aluminum reduction furnaces at low cost is one of importance, as is the problem of making electrodes for this work. Petroleum coke is expensive, and a source of cheap high grade carbon, low in ash, is desired by the aluminum industry.

Melt in Reverberatory Furnaces

Aluminum from the reduction cell is remelted for pouring into pigs or rolling ingots in the plants of producers. The melting is carried out usually in furnaces of the reverberatory type, in which firebrick is used for the hearth. Silicon and iron are taken up by liquid aluminum from such hearths, with resultant contamination of the metal, and since no refining can be done with aluminum, as is the case with most other metals, it is desirable to eliminate contamination wherever possible. The Baily electric furnace, with a lining of brick for the hearth, has been used for melting the aluminum reduction-cell product.

Aluminum alloys are melted for fabrication into sheets, rods and shapes; for the production of castings in foundry practice; and for the production of castings in die casting, and for casting in permanent molds. The alloys are melted in a variety of furnaces, but chiefly in iron-pot furnaces or in crucible furnaces, unless the production is large when furnaces of the reverberatory type are employed.

It is in light alloy foundry practice that the greatest variety of furnaces is employed. For founding, aluminum alloys are melted in the following types of furnaces at the present time; coal, coke, gas, and oil-fired reverberatories; oil and gas-fired stationary, and tilting iron-pot furnaces; coal and coke-fired, natural and forced-draft pit furnaces, using a crucible; oil and gas-fired stationary and tilting crucible furnaces; oil and gas-fired open-flame tilting and rotating furnaces; and two or three kinds of electric furnaces.

In the case of large reverberatory furnaces, the refractory is usually firebrick,

Paper presented to the American Ceramic society. The author, Robert J. Anderson, is metallurgist, United States bureau of mines experiment station, Pittsburgh.

and these furnaces are useful where the foundry capacity is large, and where large scrap, such as crankcases, is melted. Stationary cylindrical furnaces of the new Schwartz type have been installed at two or three foundries, and at one plant zirconia is to be tried for the refractory. In the case of iron-pot furnaces, the shell is lined with firebrick, and the alloy is melted in a cast-iron vessel. The cast iron is usually ordinary gray foundry iron. Pots of this type fail by stretching, scaling, and fissuring, and the average life is only about 40 heats. Cast-iron pots also cause contamination of the aluminum alloy with iron, and they are not suitable for melting some alloys. They are eaten away readily by liquid aluminum-zinc alloys, and are not satisfactory for melting duralumin because iron is introduced.

Crucible Furnaces Used

Graphite-clay crucibles are used in pit furnaces and in crucible furnaces as the containing vessels. Such crucibles are more readily attacked by aluminum alloys than by brass and bronze. Makers of crucibles state that they have a special clay-graphite mixture for crucibles to be used for aluminum alloy melting, and information on this subject would be useful to foundrymen. Not a large amount of aluminum alloys, as referred to the total output, is melted in crucible furnaces, but in most small foundries pit or crucible furnaces are employed for melting.

In some foundries, open-flame tilting or rotating and tilting furnaces are employed for melting. Firebrick and rammed ganister linings are employed. In one plant, the rammed ganister lining has been exceptionally good, as much as 2,000,000 pounds of alloys having been melted with one lining in a 36-inch furnace. Electric furnaces are employed in a few foundries for aluminum-alloy melting, and the refractory is usually firebrick.

The question of refractories and containing vessels for liquid aluminum alloys in die casting and permanent-mold casting is important. In the case of die casting, the problem has never been satisfactorily solved, and research on the subject is required. For die casting, the alloys are made up in a melting furnace, the iron-pot furnace being favored, and cast into small pigs preparatory to delivery to the die-casting machine. In casting, the liquid alloy is contained in a small iron pot, the temperature of the alloy being about 700 to 750 degrees Cent., and is forced into the die by air pressure. A submerged nozzle of cast iron is suspended in the alloy, and this conveys a charge of liquid alloy to the die plate opening. Air pressure then forces the alloy into the die. Cast iron is used both for the holding pot and for the nozzle, and the amount of iron dissolved is high. When running aluminum-copper alloys with the desired composition of 8 to 10 per cent copper and the remainder aluminum, the iron content generally runs up to 3 per cent. This gives rise to difficulty on polishing die castings because of the formation of the hard intermetallic compound, $FeAl_3$, which stands in relief on buffing. Alundum has been used as a lining for die-casting pots and as a lining and covering for nozzles, but this has not been successful.

The question of linings in secondary smelting practice for aluminum and aluminum alloys is of special importance; the life of linings in furnaces for smelting is low because of the local effects of burning. Reverberatory furnaces, crucibles, and iron pots are used in secondary practice, and the requirements of a refractory for secondary smelting are more severe than in simple melting. As is known, aluminum oxidizes readily and rapidly with increasing temperatures, and at the temperature of smelting, particularly with borings and some drosses, a thermit-like reaction occurs. This is destructive of refractories and linings. Moreover, in smelting, fluxes of various kinds are employed, and certain of these are destructive to refractories.

Electric Steel Burns Sand on Castings

Question: We are having considerable trouble with the sand burning in, especially around the pouring gate on our electric steel castings, and would appreciate your advice regarding the probable cause of the trouble.

Answer: Your trouble may be due to one or all three of the following causes: The sand you are using may not be of a sufficiently refractory character to withstand the intense heat at which electric steel usually is poured; it may be too wet; it may not be properly mixed. You do not state whether the molds are formed in green or dry sand, but since the greater part of all the electric steel melted in the foundry is poured into green sand molds, we assume that you have reference to green sand. We are further moved to this conclusion from the fact that drying, with its accompanying coating of silica wash, automatically would eliminate the three causes outlined. The ideal sand for steel molding is silica sand. This material is practically pure silica in the form of small grains, white or light yellow in color. However, this material has no bond and therefore it cannot be used in the natural state for molding purposes. The foundryman's problem is to find a sand carrying a maximum content of silica and a minimum of bonding material. Where the sand is prepared in the foundry by grinding silica sand and clay in a revolving pan mixer, care must be observed to keep the addition of old sand and clay to a point where it does not reduce the refractoriness of the facing sand unduly. Where natural bonded sand is employed and evidence of fusion or *burning in* is noticed, the trouble may be remedied by adding from 5 to 10 per cent silica sand to the standard facing sand mixture.

Causes for Thin Scrap on Castings

By James Thomas

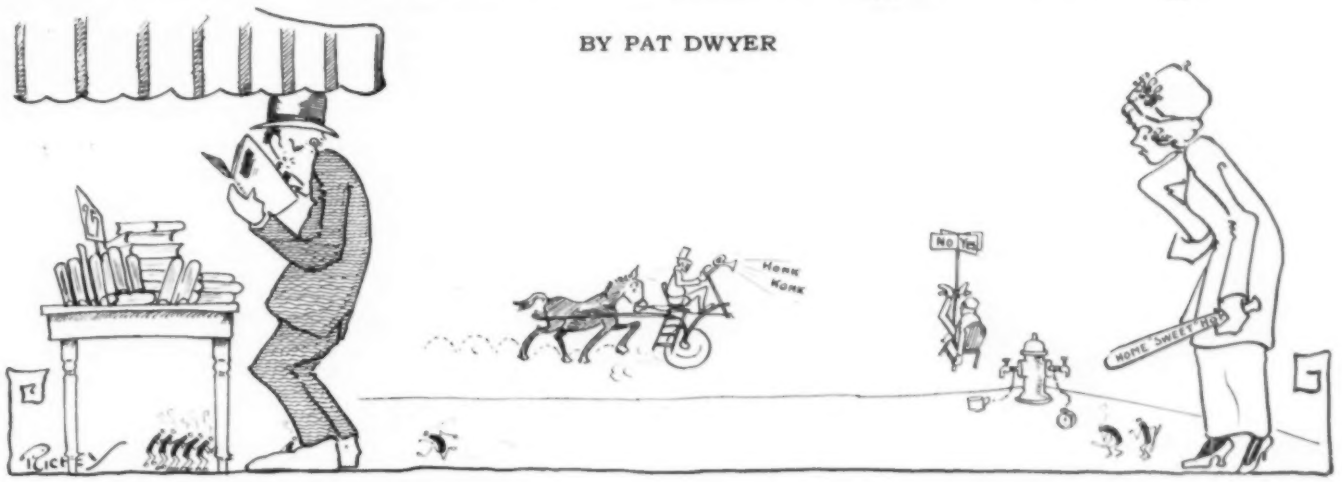
Causes of thin tissues of scrap in ingot mold castings can be traced to the sand being too closely grained, which prevents the gases from escaping properly. The corebar should be vented freely and the vent holes should be cleaned. An excess of new sand in the cores also causes defects in the castings and results in the core being hard to clean. In pouring a perfectly dry mold made from closely grained sand and containing a core, careful observation will show an agitation against the core as the metal rises. This is not strong enough to result in buckles or to cause the blacking to come off the core in dust. As the metal continues to rise this agitation is strong enough to force a film of blacking about the thickness of paper back from the sand, thus leaving a thin lining of scrap. This does not occur all over the core, but in patches in the corners of ordinary, small and shaped molds. Plate molds are affected more on the flat sides.

Some believe that this action is caused by oxidized metal. The writer does not believe that the average metal received from the blast furnace and cast direct could be oxidized to the extent of causing this condition. However, the analysis of this thin scale of metal shows the silicon reduced and the sulphur increased in comparison to the metal in the remainder of the casting. This shows the scale is not caused by oxidized metal, since oxidization takes place only in the scale formed. If the metal used were oxidized the thin tissues of scrap would be evident in other parts of the casting instead of being found only along the core.

Burt Core Sand Co., Detroit, producer of bank core sand has re-elected the following officers for 1924: Warner R. Thompson, president; R. J. Mehlman, vice president; F. J. Snyder, treasurer; and J. E. Love, secretary.

Bill Airs Views on Sashweight Castings--IV

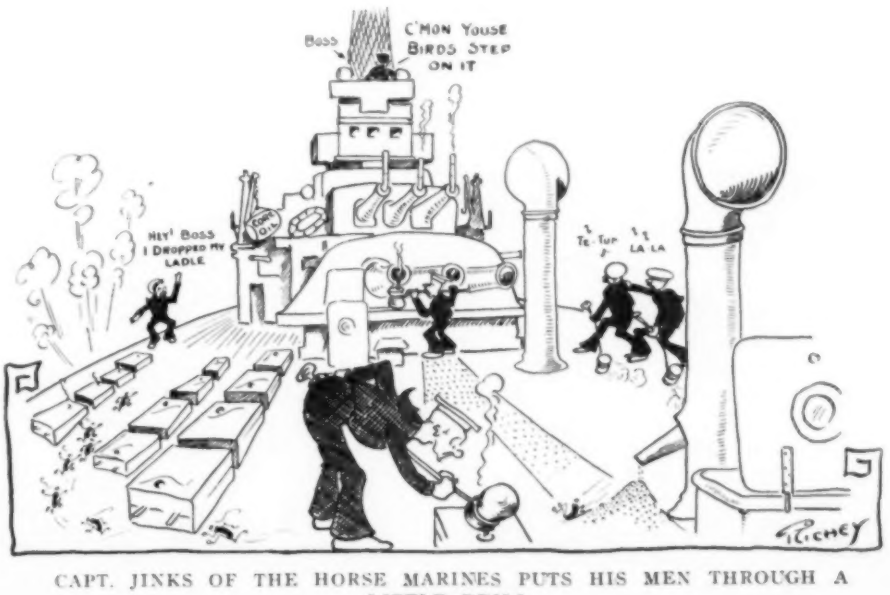
BY PAT DWYER



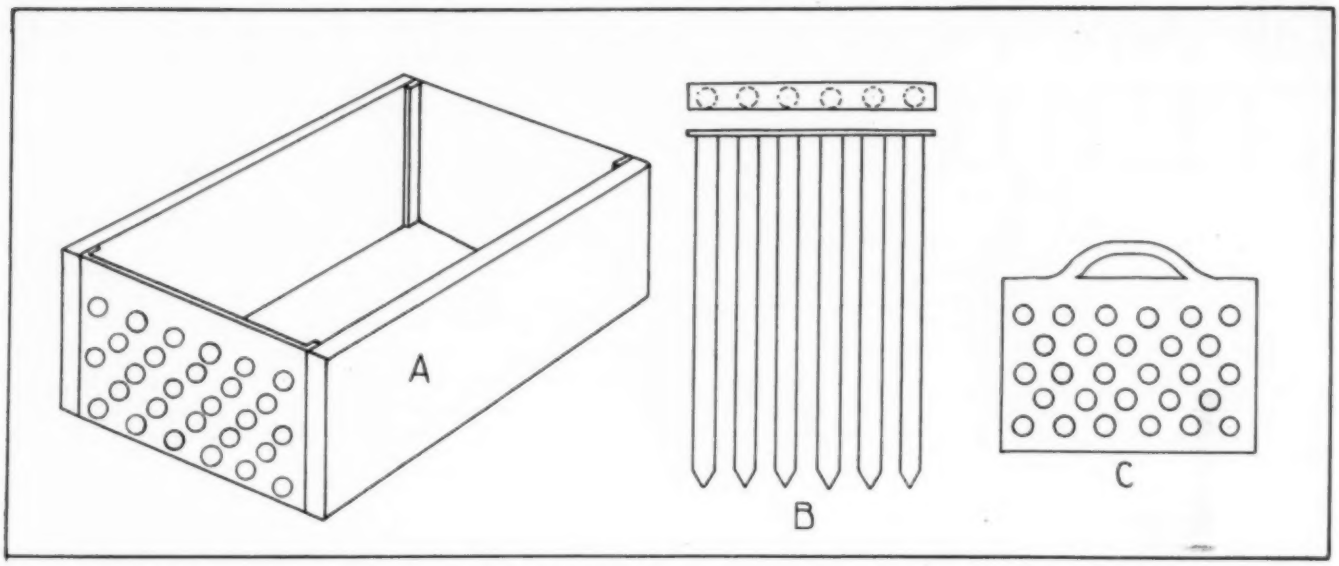
EVERY day—that is every working day—about the hour of noon, in company with two or three other hardy and hungry adventurers I ooze out of my little cage and proceed at a decorous gait to a quiet place where I take on a sufficient supply of food and water to keep the old engine going until I make the home port in the evening. On the way to and from the oasis in the desert, we pass by a second-hand book store where a tempting array of books, old and new, big and little is displayed on a wide shelf outside the window. Nearly every day the collection is changed and new titles continually are turning up to tempt one's interest. A modest sign announces that a choice of any single book may be had for the insignificant sum of 25 cents while a second line terminated by an exclamation point directs attention to the fact that five (5) volumes are at the disposal of any person willing to part with $1, check, bills or silver. Always since I can remember a book store has presented an irresistible attraction and while, of course, I cannot prove the point, still I am satisfied no woman ever gazed at a window full of summer finery with greater avidity than I have gloated over the titles of a window full of books. Looking back now over the long, long road I have to acknowledge a debt of gratitude to a quiet and undemonstrative father above whose lowly resting place the sod has been growing green for many a year and the sight of a book store never fails to bring back a vision of the day he took my timid little hand in his and led me into one of the treasure chambers to buy my first copy book. From my own parental experience in later years I am inclined to the opinion that he enjoyed a certain amount of reflected pleasure from the rapture with which I gazed around and sniffed at the delicious booky smell. Before we departed he allowed me to select a 2-penny illustrated copy of that inimitable classic *The Babes in the Wood*. The exquisite pleasure of actual possession was too much. My cup of happiness was filled to the brim and to my horror and embarrassment I found my little eyes and nose overflowing, no doubt through sympathy.

I touched the peaks of paradise again a few years later when a gentle little mother at my earnest and thoughtless solicitation dipped into the chronically emaciated family purse and gave me 15 cents to buy a paper covered copy of *Robinson Crusoe*.

Occasionally I yield to temptation and squander a quarter for a masterpiece, but as sure as I do and so sure as I bring it home, I hear an expert, if ladylike opinion, touching on the propriety of allowing a person in my condition to wander loose around town without a competent guardian. She cannot understand why any normal human being gifted with even the rudiments of intelligence could be induced to handle and read an old book that goodness knows what or how many queer people may have handled and read previously. "The city maintains a magnificent free public library," she says. "Where books are cared for in a proper and hygienic manner. You have a drawing card, several of the older children have cards which confer the privilege of borrowing as many books as you or they can find any use for. Still in the face of all that you deliberately go pawing over a pile of leftovers and throw away a couple of dollars over a specimen that I would not throw in the fire with a pair of long handled tongs." My innocent explanation that the book only had set me back to the extent of a quarter of a dollar is turned skillfully to confound



CAPT. JINKS OF THE HORSE MARINES PUTS HIS MEN THROUGH A LITTLE DRILL



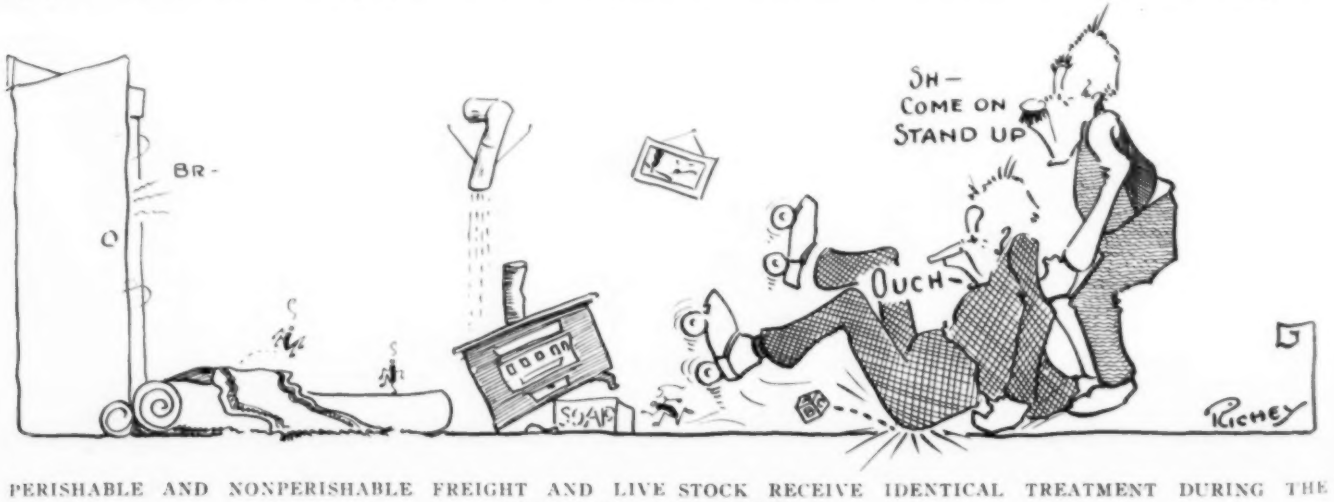
THE PERFORATED PLATE *C* SERVES FOR BOTH RUNNER AND LOCATION PLATE AT ANY DESIRED POSITION IN THE FLASK *A*—THE PATTERNS *B* MAY BE ATTACHED TO A BAR AS SHOWN OR EMPLOYED SINGLY

and condemn me. I am told that even a child should know that when a bound book is sold for 25 cents something radically is wrong with it. The book seller must have got it for nothing or he could not sell it for such a trifling sum. She should not be at all surprised to find that in all probability at one time it had formed part of a second hand collection pitched out of a pest house or an old abandoned leper colony and that at the present time it is reeking with germs and microbes and all manner of abomination. She warns me that if the house is quarantined I can't deny that I was not warned. Even if I have no regard for my own health at least I might show a little consideration occasionally for the health and convenience of a dependent wife and children. Heaven knows under modern city conditions the dear children are sufficiently handicapped in the race of life without having their innocent health and even their very lives jeopardized by the deliberately silly performance of a careless and criminally negligent father. Hard words says you but at best it is a hard life mates!

Bill came rambling in the other night while I was putting up a fairly good imitation of an interested listener to one of these lectures. Long and diligent practice has made me reasonably proficient in what universally is recognized as a fine art. Any person can listen, but your amateur or your operator lacking in skill or experience is apt to under play or over play his hand. In the first instance he remains quiet too long and the lady gathers the impression that some of the finer points are, as the poet says, being wasted on the desert air. In the second instance the listener goes to the other extreme and in his pseudo-enthusiasm comes to bat too often. Instead of cutting down on the total time as he anticipates, this practice only serves to prolong the argument. Every little drop of oil in the form of innocent words thrown on the troubled waters furnishes the lady with a new text to be developed and expounded in a fit and proper manner with full accompaniment of fife and drum. As I said I pursue a discreet middle course saying little or nothing as circumstances may dictate and as a result the storm dies down or blows over. Then I read the book without any further comment.

It was even so in this case and the well known dove of peace was engaged in the familiar occupation of preening its wings on an imaginary perch when Bill almost frightened it out through the window by his opening remark. He said he quite agreed with the lady in all she said about secondhand books. In fact he was prepared to go further and say the world would be better off if most of the books in existence were dumped in the approximate center of the deep blue sea. He admitted that many worth while books had been written in the past, but the present crop constituted a pitiful exhibition.

"The magazine stories," said Bill, "to a great extent are no better. Recently I read one describing in great detail an episode in a foundry maintained and operated on one of the vessels of the United States navy. I have read some wild tales in my time.



PERISHABLE AND NONPERISHABLE FREIGHT AND LIVE STOCK RECEIVE IDENTICAL TREATMENT DURING THE HOUSE CLEANING PERIOD

but they had to present an element of plausibility to hold my attention. In many cases it is probable that I was not competent to appraise this feature at its true value, but if my limited knowledge prevented me from detecting a flaw I was willing to accept the author's word for it.

"This is particularly true of stories dealing with mysteries of high finance, the effects of certain drugs and the peculiar tangles ensuing sometimes through due process of law. All this stuff, like the birds, is over my head, but I am willing to follow the hero through it all uphill or down by land or sea provided the author is not a dummy who limps, or who clumsily insists on setting down his ideas in slovenly English. If the author chooses to set the hero digging an oil well in the Sahara desert several hundred miles from Timbuctoo, I do not throw the book away in disgust. I never have been either in the Sahara or Timbuctoo and while my meager knowledge of the territory would indicate that the hero probably is a nut, I would be content to follow his adventures if the text led me to believe that the author is familiar with his subject. My knowledge of the navy is limited to what I gleam from the zealous newspapers that are published by, of and for us great common people. In a general way I have gathered that a technical error has been committed in equipping naval vessels with oil burning boilers. I am not in a position to judge the veracity of the various statements, but in a general way I have gathered that unless some of our eminent statesmen are not summarily hanged, drawn and quartered, the available supply of fuel oil in a few years will not be sufficient to carry a captain's gig across the Potomac.

"However, I do pretend to some slight knowledge of foundry conditions and practices, either afloat or ashore and that brings us back to the magazine naval story on which I started to comment. The whole story was built to lead up to a climax in which a wet mold was to explode and burn every person in the vicinity. The idea was plausible, but the author exposed his ignorance of practical detail in the manner in which he had this degenerate character of his carry out his design. This bird selected a mold for a throttle valve and at a time when all the men temporarily had left the foundry he poured a pailful of water down the runner.

"The author then devotes two or three pages to this precious lad's mental reactions before the time came to pour the mold. Revenge and remorse alternated until the last minute, when of course, his better nature triumphed and while carrying the single end of a ladle shank he deliberately stumbled over the mold and destroyed it so that it could

not be poured. When he fell the iron from the ladle slopped all over him and we are told that as the horrified gang bore him tenderly to his bunk, he smiled happily at the reflection that he had acted the part of a red blooded he-man and had purged all the rottenness out of his system.

"Pure bunk, I calls it. From the early description of the lad's character I doubt if any treatment short of complete immersion in a 10-ton ladle or a bath in boiling oil would purify him. I am not prepared and I have no desire to debate the point. The point to which I want to direct your attention is that this slinking waster poured a pailful of water down the runner of a small mold and the condition of the mold escaped the notice of several experienced molders who arrived on the scene shortly afterward. The sand in a small mold will absorb a certain amount of water, but most assuredly it will not absorb a pailful and a considerable quantity will leak out around the bottom board and it simply is the height of nonsense to assume that it will escape the notice of the practical men on the job."

"I don't see any reason," I said, "why you should get all excited about the thing. Probably the great bulk of the magazine's readers considered that story a bang-up piece of work, full of action, pep and vinegar and incidentally an interesting description of a little known phase of the navy's activity."

"Maybe so," said Bill. "Maybe so. The point is well taken by my honorable friend. What's past is past and is of no more practical value than water that has flowed over the dam or the other beautiful amber stream that flowed so freely and served such a useful purpose in irrigating a parched section of humanity before Mr. Volstead dynamited the spring and diverted the stream to a myriad of underground channels. Alas! Let us tear ourselves away from a contemplation of such useless subjects and devote our attention to some of the higher things of life. Onward and upward. Excelsior and all that kind of thing if you get what I mean. In a word lend me your blinkin' ears while I say a few words on the great national, indoor, foundry game of making sashweight castings, for nothing or as close to nothing as possible. In a method practiced quite extensively in some places the castings are molded horizontally in several tiers superimposed on each other in a deep flask. This method has many commendable features. A large tonnage may be molded on a small floor space. The castings will show no longitudinal seams. Plain drag flasks only are required. The pattern equipment easily is prepared. The molding procedure is within the capacity of comparatively unskilled labor. The castings may be poured from a crane ladle and thus eliminate one of the most disagreeable features usually associated with the production of sashweight castings. Let's see that precious book of

yours and I'll make you a little sketch of the rigging required and then I can explain the process more readily."

He calmly appropriated the book I held in my hand and with a little stubby pencil made a sketch on the flyleaf. He handed it back with the laconic comment that if the book still was no good, at least the flyleaf had served a useful purpose.

"The number of flasks required will depend on the anticipated output, but the description of one will serve for all. The patterns may be adjusted to make any desired length of casting within the capacity of the flask but to save sand and work it is advisable to provide several flasks of assorted lengths.

"Formerly the flasks were constructed with wood sides and cast iron ends. One end was a plain plate and the other end was pierced with rows of 2¼-inch openings arranged in such a manner that the openings in one row were staggered in relation to openings above and below. This arrangement prevented the castings in one row from bursting into the molds immediately above. During the pouring process the bottom row of molds is filled first, then each row above is filled in succession. This arrangement also precludes the possibility of straining the lower castings. This style of flask is fairly satisfactory, but I think if I were equipping a foundry at the present time I would order a supply of steel flasks from one of the manufacturers of foundry equipment who specialize in this product. From the nature of the work it is apparent that the flasks are subjected to rather severe service.

"The patterns are made from sections of 2-inch steel pipe, threaded at one end and closed and drawn to a fine point at the other end. The number of patterns is not arbitrary, but will depend on local conditions. Two sets will be required. In one the number of individual patterns will be less by one than in the other. This arrangement is necessary to maintain the staggered relation between the molds in one row and those in adjoining rows. Instead of attaching pipe patterns to the flat steel plate as shown at *B* they may be used individually. The advantage of the bar construction is that time is saved in drawing the entire number with one movement. With everything in readiness the mold is made in the following manner.

"The flask is placed approximately level on the foundry floor and the steel plate *C* which serves the double purpose of a runner and a locating device is erected at a point in the flask to correspond with the desired length of the castings. The first row of patterns is inserted through the lowest row of openings in the end of the flask and pushed forward until the sharp points locate themselves in the lowest row of small openings in the plate *C*. Sand is rammed around the patterns and then the second row of patterns is inserted in like manner in the second row of openings in the end of the flask. After the sand is packed around the second row of patterns, the first row is withdrawn and reinserted through the third row of openings in the end of the flask. This procedure is repeated until all the openings have been utilized.

"Sand on top of the flask is scraped off level, a plate is bedded down and weighted to resist the upward pressure of the metal. A basin is cut in the sand back of the plate *C*, after which the plate is drawn out of the sand and placed in another flask where the foregoing process is repeated. A cast iron plug in two parts or a small dry sand core is inserted in each of the openings in the end of the flask to form the eye of the sashweight casting. The space around the end of the plug is daubed with mud to prevent a run-out and the mold then is ready for the iron.

"Several other methods are available for making these castings—Oh! well if you don't want to listen—on some future occasion when I have the time, the inclination and the opportunity I will expand a trifle on molds that are jolt rammed vertically, on section molds and on chill molds. Farewell me hearty until we meet again."

Enameling Sanitary Ware Delicate Process

Question: We should appreciate any information you may be able to give us on the subject of enameling bath tubs. What ingredients make up the mixture; how is it prepared and applied?

Answer: A successful mixture is obtained only after careful study and experiment. The same formula is not adapted to all work, because of the various types of smelting and muffle furnaces employed, the different methods of applying the enamel, the kind of metal used as a base and the chemical constitution of the available materials. Enamel is a form of glass and therefore it is apparent that sand or silica is the base of the enameling mixture. Other materials employed in the enamel mixture include: Tin oxide, feldspar, flint, fluorspar, borax, boric acid, barium fluoride, soda ash, sodium nitrate, pearl ash, potassium bicarbonate, potassium nitrate, red lead, manganese deoxide, bone ash, zinc oxide, cryolite, whiting. A formula for a ground coat follows: Sand 44 pounds, borax 18 pounds, saltpeter 14 ounces. This mixture is fused and then is ground with an addition of 9 per cent by weight of quartz and 12 per cent of clay. A satisfactory finish coat contains feldspar 39 pounds, sand 31 pounds, borax 31 pounds, soda ash 24 pounds, fluorspar 9 pounds, whiting 4 pounds 9 ounces, zinc oxide 6 pounds. The materials for the finishing coat is thoroughly fused and mixed and then is ground with 14 per cent of tin oxide, 7 per cent of zinc oxide and 7 per cent of clay. It is important that the tin oxide should not be added until this stage.

After the enameling mixture has been riddled through a fine sieve it is smelted in a furnace at a temperature of about 1200 degrees Cent. The molten enamel is run into water to disintegrate after which it is ground in a roller or pebble mill.

Castings to be enameled are thoroughly cleaned and for this purpose a sandblast is considered the most efficient device. Success in enameling is fully as dependent upon the method of application as upon the mixture. The ground coat in liquid form is applied either with a dipper or a spraying device. The latter is the more economical and also insures a more even coating. The casting is rocked back and forth to insure an even surface and then is dried quickly over steam pipes or by waste gas from the furnace. Blemishes in the surface are retouched. The amount of material required for a ground coat will vary, but approximately it will equal 10 per cent of the weight of the casting.

The finish coat is applied as a white powder by a mechanically operated sifter. The casting is rotated and rocked from side to side while two workmen stationed on opposite sides apply the material through long handled sieves provided with vibrators on the ends of the handles. The casting is heated in a muffle furnace to 1000 degrees Cent. for the ground coat and afterward to 850 degrees Cent. for the finish coat. After the finish coat has been applied and burned on, the casting is placed in a special chamber and allowed to cool slowly. The enameling of iron involves many difficulties. It requires skilled and careful attention at every phase and failure can be traced to many causes, some of them exceedingly obscure.

The American Engineering Standards committee has issued a small book entitled "Standardization, What It Is Doing for Industry." The methods of carrying on standardization are described, first in the individual plant, second in the industry as a whole, third nationally on an inter-industrial basis and fourth internationally. This book may be obtained from the offices of the committee, 29 West Thirty-ninth street, New York.

Wants To Use a Casting To Form a Mold

Question: We have been asked to make a set of upper and lower dies of irregular surface contour and to insure a perfect fit between the upper and lower faces. The customer has stipulated that we cast the top die first and then employ the casting to form the drag face of the mold in which the lower die is to be cast. The actual words of the customer's instructions read: The top casting is to be cast first with pins cast into the shell, the surface then coated with nonadhesive substance and the bottom casting poured, using the shell of the first casting as a mold for the second, with pins connecting them After cooling they are to be cut apart either by burning or cutting around pins. Iron is to conform to American Society of Testing Materials standard for gray iron castings.

If this was a small casting we would anticipate no particular trouble but in this instance the top die represents a casting 12 feet 2 inches long, 3 feet, 11 inches wide, irregular convex curved surface on one side and the other side heavily ribbed, an average metal thickness of 2 inches and a total estimated weight of 8000 pounds. The lower die is similar to the upper in so far as the general outline, metal thickness and ribs are concerned. It differs in that the curved surface is concave and in addition it is designed to be made in three sections, two 6-foot lengths and a third piece 2 inches thick to serve as a filling piece in the center. Our experience leads us to believe that the upper die will crack when the second die is cast against it and in any event we are afraid that one or more of the castings will have warped out of shape before the job is finished.

Answer: The absurd specifications with which you are asked to comply apparently were drawn up by a person totally unfamiliar with the basic elements of foundry practice. The contingency of warping and cracking are sufficient to condemn the idea from an operating standpoint. Even if the feat was attempted the immutable law of contraction would serve to defeat the object the customer had in mind, viz: a perfect contact between the faces of the upper and lower dies.

Let us assume that a pattern is made for the upper die and a mold made in the usual manner. It will be found that the casting is approximately 1½ inches shorter than the pattern. It is apparent that if the pattern for the lower die is made the same length as the upper casting, the resulting casting will be 1½ inches shorter than the first casting. On the other hand if the pattern for the lower die is made the correct length to provide contraction allowance it will not fit snugly on the face of the upper die casting employed to form the drag face of the mold. Or again, it may be that no attempt is made to fit the face of the lower die pattern on the face of the upper die casting. It is brought into contact at a few points merely to support it in place until the cope is rammed. The expectation is that the iron will flow over the die casting that forms the drag face of the mold and when it solidifies it still will be in intimate contact. This expectation would be justified if the surface of the casting was perfectly flat, or if it formed an arc of a circle, but in any other shape the contraction of the second casting will shift the contact points.

We do not understand the object of casting pins in the shell of the first casting, if afterward, they are to be burned or cut out. If they are set in with the object of preventing the second casting from *creeping* during the cooling process they represent wasted effort. Nothing can prevent iron from contracting. If the pins hold it at one point it will go at another and if it is held forcibly at both ends it will tear apart at the center, or wherever the weakest point happens to be. In your case you should insist on complete patterns for both dies. If the patterns are properly fitted and if the molds are made with due care and skill, the resulting upper and lower dies will fit each other.

Falkirk Uses New Methods

(*Concluded from Page 339*)

and shot iron, but into nails and many other manufactures; in all human probability this will be the case. Under this conviction it is undoubtedly right to begin our works in a situation that looks the most favorable for the seat of such manufactures and where our works may be enlarged to a great extent and notwithstanding continue contiguous to one another and in the country that seems the most convenient for manufacturers to settle on account of its nearness to the Firth of Forth and its not being remote from Glasgow and where exceeding fine coal from Acton Boughey, Toryburn, or Limekiln can be had always at a moderate expence, and charcoal be delivered cheap not only from the Highlands as well as from woods that are now near it, but the land in the neighbourhood of Carron might be rented on such terms as to make it advisable to plant large woods for the supply of our works."

Had the projectors known that before the company was 10 years old the all important water supply on the site chosen would sometimes fail and cause the works to be idle for months at a time, necessitating the introduction of steam power, they might have changed their minds and selected a different place for the establishment of their plant, particularly since the charcoal on which so much depended at first was soon superseded entirely by coke made from coal which is as easily obtained in other parts of Scotland. But the foregoing indicates the considerations which led to the establishment of an iron works on the banks of the Carron. The evolution of the famous Falkirk foundry district has been a natural results of the original activity of Dr. Roebuck and his associates.

As soon as pig iron became plentiful a crop of foundries began to spring up in Stirlingshire, particularly in Falkirk. The Falkirk Iron Works established in 1819 was the first after the plant of the Carron Co., which in the early days, as at present, made not only pig iron but finished castings in large quantities. In 1860 the plant of M. Cockburn & Co. was established and most of the other prominent works in the district originated during the latter half of the nineteenth century.

In 1880 there were 21 foundries in Falkirk making castings for shipment to points as far distant as Australia and China. The inhabitants of the town and the district are almost wholly dependent on the iron foundry business for their subsistence, and the traditional skill of the Falkirk molder has already been commented upon. With the introduction of machinery and methods such as those described in this article, this question of skill is of less importance than in the years gone by. Nevertheless Falkirk still enjoys advantages, not the least of which is the good will which its leading manufacturers have built up carefully through a long period of years, so that there is little reason to doubt but that this region may be as important a foundry center a century hence as it was nearly two centuries ago.

Bag for Collecting Dust on Disk Grinders

Instead of depending on the dust collector in the housing of a sand disk machine I have found it more convenient to take the end of the hose out of the housing and insert it in a burlap bag. The neck of the bag is tied tightly around the discharge end of the hose and serves the same purpose as the bag on the familiar household vacuum sweeper. All the fine dust will be collected in the bag instead of being blown all over the shop where it is disagreeable, annoying and hard to sweep up. The bag readily may be removed at any convenient time and the contents disposed of in any suitable manner.

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Evolution in the Foundry Industry

GLANCING back through the pages of THE FOUNDRY since its inception on Sept. 10, 1892, one of the principal features to attract attention is the gradual manner in which the industry has adopted mechanical equipment for practically all its various activities. Reduced to its lowest terms it may be said that castings now are made in substantially the same manner they were made by the first savage who spilled bronze into a hollowed stone to form a spear head. Today molten metal is spilled into a hollow formed in sand and that sand is only disintegrated rock. This fundamental feature has not changed through the centuries and probably will not change until some method is developed either for manipulating the metal in some other manner, or in producing a mold made from some material that will hold its shape indefinitely.

Along a few lines the permanent or long life mold has demonstrated its practicability and usefulness. However, the great bulk of the iron, steel and brass casting output still is poured in sand molds. That feature remains the same. Change in the methods by which the work is accomplished is what attracts the attention. Like practically every other change the transition has been so gradual that rarely is it considered worthy of comment. Only when one actually is confronted with text and illustration describing methods and equipment formerly in vogue is one made aware of the startling contrast brought about in foundry operating conditions in the comparatively short period of the past 32 years. To employ a familiar illustration it may be said that a photograph of the typical equipment used in a modern foundry differs as widely from that used in 1892 as the cloaks and bonnets of the modern Dolly Varden differ from those held up to an admiring view in the fashion plates of a similiarly remote era. They were considered the last word in sartorial elegance at the time, but now they only serve to excite the risibilities, not only of the younger generation, but of those who actually wore the garments and at the time preened themselves on the correctness of their taste, especially along this particular line.

Mechanical equipment has invaded the foundry to such an extent that a new type of workman and superintendent is being developed. The workman touches a button, a lever or a valve and a power operated device handles and prepares the sand, opens and closes the mold, draws the pattern, weighs the charge, places it in the cupola, pours the metal into the mold, shakes out the casting, cleans, weighs, and ships it.

Whether a scarcity of workmen is due to the extensive adoption of labor saving machinery, or whether adoption of labor saving machinery is due to a scarcity of workmen is beside the question. The fact remains that foundries are installing mechanical equipment more extensively year after year. Sand cutting machines prepare the sand more rapidly, uniformly and economically than it can be prepared by hand. Molding machines of various types ram the sand in the flasks at a speed that is beyond comparison with hand labor. Cranes and monorails convey iron to various points in the foundry with an ease and facility that insures hot iron in the molds and permits the operation of fast melting cupolas. Immense production of duplicate castings largely is responsible for the adoption of mechanical equipment in the foundry and the uniformity of the castings turned out under present conditions supplies at least one of the answers to the question, why are new methods substituted for old.

Trade Outlook in the Foundry Industry

CONTRADICTORY factors, always present in some degree, are strong in the industrial outlook. Business depression, while the universal topic of conversation when business men and manufacturers meet, seldom is mentioned in the first person. The same holds true among foundrymen. Ask practically any manager of a castings plant concerning the state of his orders and the rate of operation prevailing and he will remark that *his* plant is working satisfactorily, but he is informed that his neighbor or his competitor in an adjacent town is *flat*. Of course, exceptions exist, but individually, foundry operations are reported fair, with repeated small orders sustaining business.

Building at Peak

One example of the contradictory nature of prevailing conditions is furnished by the record of building contracts awarded in 27 northeastern states. The March total was the highest ever noted, and was 27 per cent ahead of February. An exceptional residential building movement in the vicinity of New York City furnished sufficient impetus to establish this high record, while in other quarters a decline was observed. Prices continue at the peak, and doubtless will serve to put the brake on some projects for the summer. However, commercial and residential requirements are large and demand may force a continued high level in construction activities. During the first three months of the year contracts were made for the largest amount of construction ever closed in a similar period. While this movement is subsiding, it is thought that the impetus given by the first few months will place 1924 ahead of 1923 for building operations. This is having a marked effect upon the demand for miscellaneous castings for building and public utility needs.

Prices for Raw Material for Foundry Use

CORRECTED TO APRIL 24

Iron		Scrap	
No. 2 Foundry, Valley	$25.00 to 26.00	Heavy melting steel, Valley	$16.50 to 16.75
No. 2 Southern, Birmingham	22.00 to 23.00	Heavy melting steel, Pitts.	15.50 to 16.00
No. 2 Foundry, Chicago	24.00	Heavy melting steel, Chicago	13.50 to 14.00
No. 2 foundry, Philadelphia	23.13 to 23.76	Stove plate, Chicago	17.50 to 18.00
No. 2 Foundry, Buffalo	21.00 to 22.00	No. 1 cast, Chicago	19.50 to 20.00
Basic, Valley	21.00 to 21.50	No. 1 cast, Philadelphia	18.00 to 19.00
Basic, Buffalo	21.00 to 21.50	No. 1 cast, Birmingham	19.50 to 20.00
Malleable, Chicago	24.00	No. 1 cast, Buffalo	19.00 to 19.50
Malleable, Buffalo	21.50	Car wheels, iron, Pittsburgh	17.00 to 17.50
Coke		Car wheels, iron, Chicago	17.00 to 17.50
Connellsville foundry, coke	$4.50 to 5.50	Railroad malleable, Chicago	19.00 to 19.50
Wise county foundry, coke	5.00 to 6.00	Agricultural mal., Chicago	18.00 to 18.50
		Malleable, Buffalo	19.00 to 19.50

March Contracts

Bookings of steel castings as reported by the department of commerce showed an increase from 73.1 per cent of capacity in February to 101.1 per cent of capacity in March. A steady gain in the total of steel castings is noted starting with October, 1923, which was the low point. On the contrary, March, 1923 showed a total booking of 148.2 per cent of capacity. Railway specialty steel castings served to sustain orders, the bookings by shops making this class of work showing 154.4 per cent of capacity for the past month while miscellaneous demand increased from 61.3 per cent in February to 66.2 per cent in March. Railway needs have served as a strengthening influence in many lines. Awards of freight cars for the first three months of the year totaled 62,642, with February showing the largest list and March registering a decline. However, the past month's buying was the heaviest since March, 1923, with the single exception of February, this year. The total of unfilled orders for locomotives has been growing slowly since the first of the year.

Automotive Prospects

Conflicting reports make difficult any positive statement relating to automobile manufacture. A large maker of specialties, selling a product to practically all classes of automobile plants is operating full time. A representative of this firm stated that while their business was satisfactory, he *understood* that a certain builder of passenger automobiles was shut down. His information was not supported by facts, as the automobile plant he mentioned was at that time and continues to operate on 35 cars a day, while its maximum capacity is only 70 cars. On the reduced schedule it is possible to maintain a full force and to show earnings on its investment. The rate of production undoubtedly is curtailed, but Michigan automobile plants continue to make in the neighborhood of 12,000 cars a day, which is a fair average production. Gray iron jobbing shops, in general, are working on a hand-to-mouth basis, with no accumulation of orders, but with sufficient business at hand to sustain operations. The Ohio State Foundryman's association reports an increase in March. The February rate of production was 74.1 per cent of normal, while March showed 79.9 per cent. The total stocks of pig iron and scrap on hand increased from 78 per cent in February to 84 per cent in March, while March, 1923 showed 95.2 per cent as the total of stocks on hand. Buying of raw materials, according to this report, has slackened, as stocks received stood at 59 per cent during March and 60 per cent in February. Little forward buying is observed. Recent reports of the National Purchasing Agents association show that the consumption of coal for industrial purposes increased 3½ per cent during March. Cast iron pipe sales continue to furnish ample business.

Nonferrous Operations

Brass foundry activities were slightly curtailed during March according to the report of the Ohio State Foundrymen's association. February showed operations 66 per cent of normal, while March recorded 65.4 per cent. Plumbing goods foundries have decreased their production slightly, as sales dropped in March. However, with building operations increasing this situation is expected to improve. Nonferrous prices according to New York quotations in the *Daily Metal Trade* of April 24, follow: Casting copper 13.25c; electrolytic copper, 13.62½c; Straits tin, 49.50c; lead, 7.90c; antimony, 9.50c; aluminum, No. 12 alloy, open market, 22.50c to 23.00c; nickel, 30.00c. Zinc is 6.12½c E. St. Louis, Ill.

Personal

Gilber H. Johnson, for five years sales manager of Isaac G. Johnson & Co., Spuyten Duyvil, N. Y., has become connected with the Farrell-Cheek Steel Foundry Co., Sandusky, O., as its eastern sales representative. Mr. Johnson will have his headquarters at Spuyten Duyvil for the Farrell-Cheek company. He was sales manager of the Isaac G. Johnson Co., at the time it wound up its business as a steel foundry.

M. W. Gleisner has been made superintendent of the malleable division at plant No. 2 of the Stowell Co., Milwaukee. Mr. Gleisner formerly was superintendent of the Southside Malleable Castings Co., Milwaukee.

W. D. Stearns, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., addressed the April meeting of the Pittsburgh Foundrymen's association, held at the Carnegie Institute of Technology, April 21, on "Foremen Training."

Frank B. Gilberth, Montclair, N. J. has been elected a member of the Nasaryk academy of Czechoslovakia, in recognition of his work in promoting scientific managment. Election to the academy constitutes the highest scientific honor in Czechoslovakia.

Discuss Semisteel Before British Foundrymen

"Semisteel, Its Advantages and Disadvantages, Properties, Mixtures, Melting and Heat Treatment" was the subject of a lecture by Prof. A. Champion, Glasgow, England, before the Birmingham branch of the Institute of British Foundrymen, recently. Professor Champion described a number of experiments carried on in small cupolas which showed that the steel in the mixture melted before the pig iron began to melt, which was due, he thought, to the high temperature developed. Another experiment was made with bars of iron and bars of mild steel of equal size combined together in a charge. It was found that the steel melted before the pig iron or at just about the same time when the pieces were of equal size and that there was no great carburization of the steel. He stated that this test rather upset the argument that carburization took place through contact with the pig iron before it melted.

Mr. Champion said that the principal point to be considered in the composition of semisteel was the adjustment of the total carbon and the proportion of the total carbon required in a combined condition for any particular job. For ordinary castings it might range from 3 to 3½ per cent and for castings such as those used with superheated steam the maximum should be 3 per cent. The best results for many classes of work require from 6 to 7 per cent which not only gives strength but also good wearing properties. For a thickness of 2½ or 3 inches the total carbon and silicon should vary from 4 to 4.2 per cent. For castings between 1 and 2 inches thick the total should be from 4.1 to 4.3 per cent and for thin castings it should be about 4.7 per cent. Where steel was used in the charge there was a greater tendency for sulphur to be absorbed from the fuel and the products of combustion. This is due partly to the steel acting as a purifier of the gases in regard to sulphur, and partly to the fact that the affinity of the purer metal for sulphur is greater than that of pig iron. It is due also to the relatively strange action of the gases on pieces of steel.

GILBER H. JOHNSON

Purchase Part of Plant

The Doehler Die Casting Co., Brooklyn, N. Y., has purchased the die casting department of the Light Mfg. & Foundry Co., Pottstown, Pa. The die casting department will be operated under the title of the Light Mfg. & Foundry division of the Doehler Die Casting Co. The foundry, machine shop and motor assemblying departments will continue to be operated by the Light company.

The New York office of the Bury Compressor Co., Erie, Pa. now is located at 50 Church street.

Obituary

Thomas M. Fillingham, vice president and chief engineer of the National Valve & Mfg. Co., Pittsburgh, died recently while on a business trip to Farrel, Pa. He collapsed in the plant of the American Sheet & Tin Plate Co. at Farrel, and was pronounced dead a few minutes later in the emergency hospital of the plant, efforts to revive him with a pulmotor proving futile. Mr. Fillingham was aged 44 and was apparently in good health when he left Pittsburgh early in the day to inspect work being done in the American company's plant.

Albert L. Swett, head of the A. L. Swett Iron Works, Medina, N. Y., operator of gray iron and brass foundries, died at his home in that city April 12. He also was head of the Medina Mfg. Co., manufacturer of hardware specialties and formerly was president of the Western New York Utilities Co. His death was due to injuries sustained in an automobile accident last fall.

Organize New Firm

The Smith-Heylandt Co. with home offices at 2633 4th St., Southeast., Minneapolis, Minnesota, has been recently organized to take over the patents, importation, sales and distributions of apparatus for the manufacture of oxygen and other gases by the liquefaction process. Liquid oxygen breathing equipment will also be manutured.

Elmer H. Smith is president of the new organization, John R. R. Miles will be secretary, and Herman G. Amling, former representative of the Heylandt Co., will co-operate with the new organization.

To Sell Surplus

The Central Sales Office Navy Yard, Washington, D. C., will sell by public auction at the U. S. Naval Ordnance plant, South Charlestown, W. Va., at 10 a.m. May 14, 1924 surplus material including pig iron, scrap iron and steel, ferro manganese, ferro silicon, ferro vanadium, ferro chrome, copper scrap, and bronze scrap.

The Gibb Instrument Co., Bay City, Mich., manufacturer of electric welding equipment, announces the appointment of Glenn A. Wilson as manager for the New York and New England territories, with headquarters at 120 Liberty street, New York. Mr. Wilson formerly was representative for the Mutual Electric & Machine Co.

Make Changes in Design of Dump Bucket

Changes in the design of a manually loaded dump bucket have eliminated the necessity of a man following the bucket to the place where it is to be dumped, as the operator of the crane stationed in his position can dump the bucket without outside assistance. In the accompanying illustration Fig. 1 shows the bucket with the bail down in the position for loading. In Fig. 2 the bucket is shown in the position of being lifted. This is accomplished by moving the crane so that the bail rests against a stop on the side of the bucket. When the bail is raised a block is pushed in a slot between the stop and the tipper cam, in this way preventing the bucket from tipping.

The bucket is shown in the position of dumping in Fig. 3. The crane operator dumps the bucket by lowering it to the ground and slackening the cable which allows the bail to lower in the slot. The bail is then tilted by coming in contract with a stop just beneath the tripper projection. The operator then moves the crane slightly and pulls upward, causing the bucket to dump the load. In this method the load merely spills out of the bucket, avoiding the impact caused when dropping a load. A level place is not required for dumping, as it is claimed the bucket will operate at practically any inclination or position.

The new device is adaptable to service in steel mills, handling roll scale spiegel, hot cinder, hot crop ends from shears and saws, concrete sand, gravel, dirt, brick, etc. This bucket is being introduced by the Jno. D. Hiles Co., Oliver building, Pittsburgh.

Plan Malleable Plant On Pacific Coast

The Pacific Malleable Casting Co., Oakland, Cal. has been incorporated for $500,000 jointly by the Rockford Malleable Iron Works, Rockford, Ill., and the Best Steel Casting Co., Oakland, Cal. The announcement of the erection of a plant to supply the large west coast demand possesses unusual interest.

W. A. Forbes, president and G. O. Forbes, secretary and treasurer of the Rockford Malleable Iron Works, which was established in 1854 and has an annual capacity of 24,000 tons, have been identified for years with the malleable iron industry in the East. H. H. Whiting, president of the Best Steel Castings Co. is well established in business circles on the coast.

Work on the first unit will start immediately after the purchase of 15 acres at the southwest corner of Eighty-fifth avenue and the Southern Pacific tracks with a frontage of 1000 feet on the main line of the railroad and 1300 feet along the avenue. This unit will consist of a modern malleable foundry containing approximately 57,000 square feet of floor space, as well as the necessary office buildings, pattern storage rooms, etc. The capacity of this unit will be 750 tons of castings per month, and production will start as soon as the plant is completed. The output will go to automobile companies, railroads, street railways, tractor plants, manufacturers of plows and farming implements, shipyards, oil well industries, etc.

H. H. Whiting, president and John Tuohy, vice president of the Best Steel Casting Co. will hold similar offices in the Pacific Malleable Casting Co. pending the final organization of the new company.

To Hold Annual Meeting

The fifth annual conference of the National Association of Office Managers will be held at Niagara Falls, Canadian side, June 12-14. The program, which now is being planned, includes such subjects as "The Office Manager's Responsibility," "Destroying Old Records," "Traniing Employes," "The Schools and Industry," "Constructive Supervision" etc.

Tests Enameled Ware

Enameled iron ware is much more likely to wrap if the iron and enamel have different rates of thermal expansion than if they expand and contract at the same rate, according to a recent report of the United States department of commerce. Tests made by the bureau also have shown that warping is less likely to occur if the grease is burned off than if it is taken off with chemicals. Warping may result from sudden, irregular cooling or from failure to support the ware properly when firing. Thin metal is found to warp more easily than thick, but is more easily straightened.

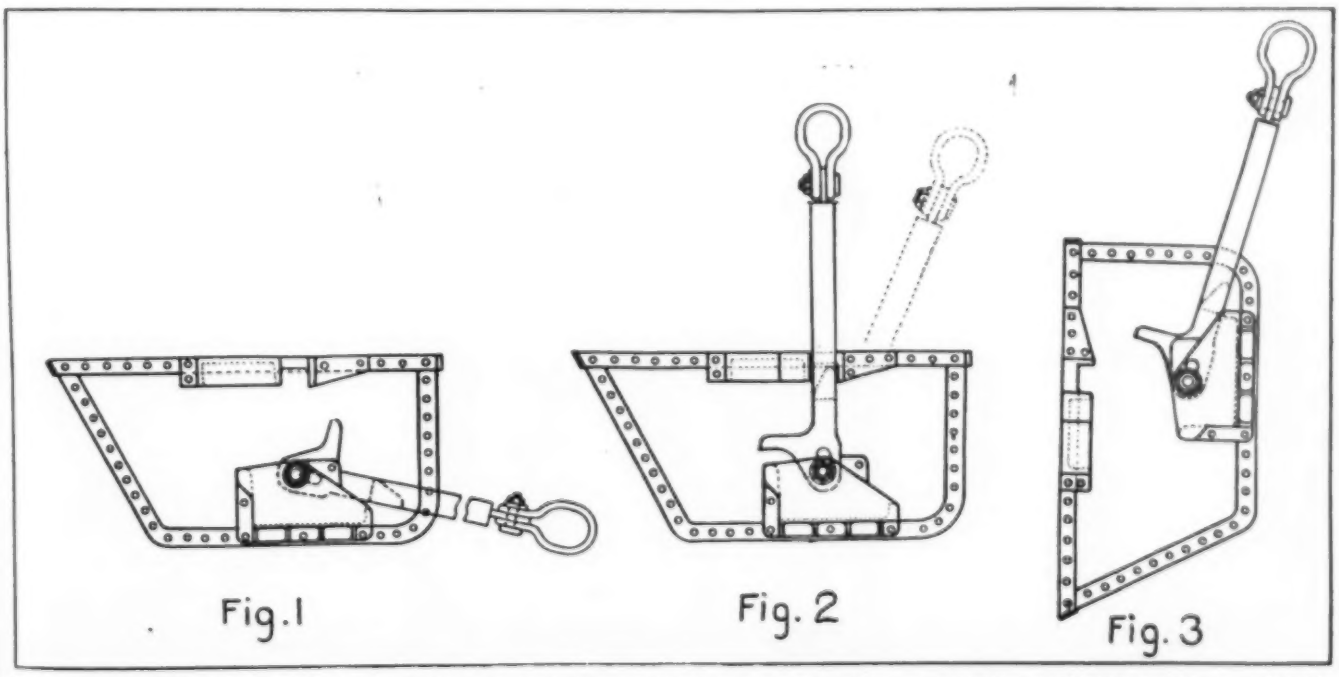
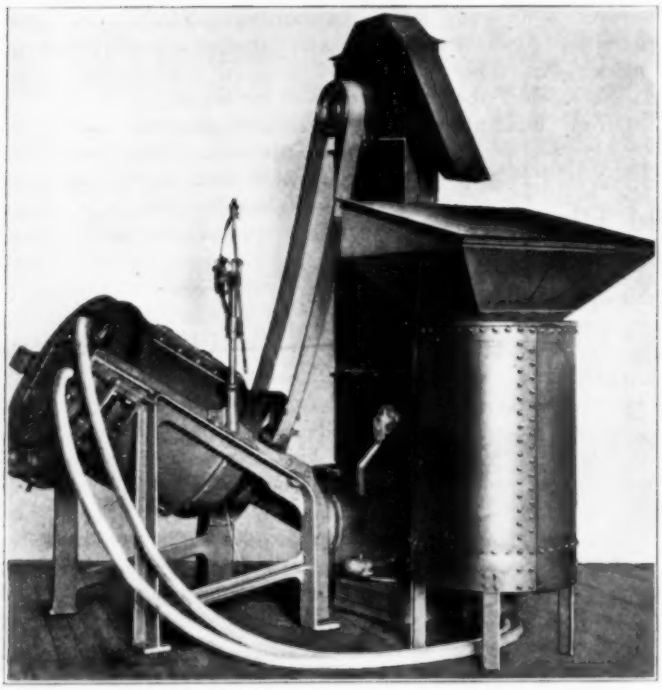


FIG. 1 POSITION OF THE BAIL WHEN THE BUCKET IS BEING FILLED—FIG. 2 LIFTING POSITION—FIG. 3 BUCKET IN THE DUMPING POSITION



TILTING BLAST MILL BUCKET ELEVATOR AND PRESSURE TANK CONSTITUTE THE CLEANING UNIT

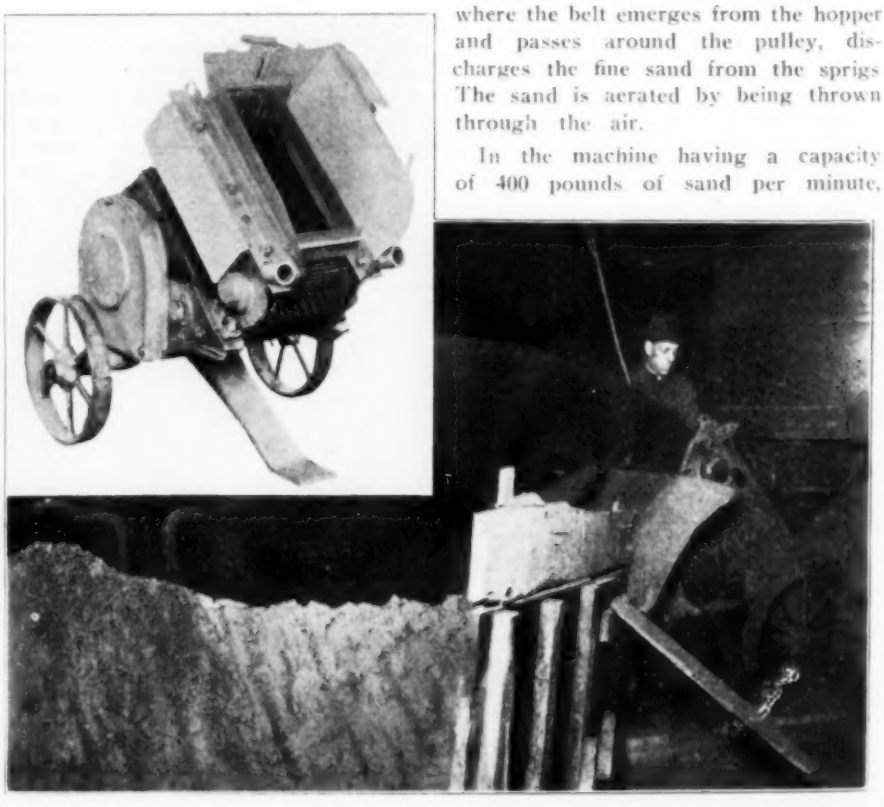
Tilting Blast Mill Has Pressure Tank

The W. W. Sly Mfg. Co., Cleveland, has combined the tilted type mill, manufactured by this company, with a sand-blast, pressure tank and bucket elevator to make a new type cleaning unit. The tilted mill consists of a barrel constructed of 1-inch flange steel, and is supported by a frame and specially designed bearings. The blast enters the barrel at the top door through sandblast guns and the dirt and abrasives pass through a perforated steel plate at the bottom. The shape of the bottom plate and the angle at which the barrel is tilted cause the castings to be turned about when the barrel revolves.

After the dirt and sand passes from the barrel, it enters the bucket elevator and is elevated to the hopper screens over the pressure tank. The abrasive is reclaimed by being separated from the waste particles by a series of screens, and is returned to the sand-blast pressure tank for release. The pressure tank has an automatic filling device in the hopper at the top of the tank, its operation being controlled by a specially designed 5-way valve. Compressed air is admitted to the tank by turning the vale lever clockwise from the off position. Air in large volume enters the mixing chamber at the bottom of the tank through the booster pipe and the abrasive control pipe with a further movement of the valve toward the second position on the dial.

The abrasive control pipe admits air to the top section of the mixing chamber. This air forces the abrasive from the feed plate into a large stream of compressed air from the booster pipe, and actual blasting takes place. The desired mixture of air and abrasive may be obtained by moving the lever to various positions as indicated by positions 2, 3 and 4. Turning the valve as far as it will go beyond 4 shuts off the abrasive supply and leaves the booster pipe open to the hose. The first turn of the five way valve automatically raises and closes the filling valve in the top of the pressure tank. When the lever is returned to the off position, the pressure in the tank is released and the filling valve drops into the supporting pipe, permitting the abrasive to fall into the storage hopper.

The tilting mill is built in two sizes, one having a diameter of 48 inches and a depth of 42 inches, while the smaller one has a diameter of 30 inches and a depth of 30 inches. The cubical contents of the first is 43.75 cubic feet and of the second 12.25 cubic feet. The weight of the loads are 1530 and 500 pounds respectively. A view of the cleaning unit is shown in the accompanying illustration.



MACHINE DISINTEGRATING AND AERATING SAND TREATED IN A MIXER—ABOVE—SEPARATOR WITH 400 POUNDS PER MINUTE CAPACITY

Builds Sand Separator and Blender

A machine, designed to blend or compound the various ingredients of facing, core or heap sand into a homogeneous mass and to remove the scrap metal from the sand, has been introduced by the Royer Foundry & Machine Co., Wilkes-Barre, Pa. This machine is built in both the portable and stationary types and is made in three sizes having capacities of 400, 700, and 1000 pounds of sand per minute respectively. The machine is simple in construction and may be taken to various parts of the foundry either by hand or crane.

The combined principles of the harrowing, gravity and centrifugal force are utilized in the operation of this machine. Sand is shoveled into a hopper in which the bottom is formed by a rapidly moving endless belt thickly studded with steel sprigs. The sprigs comb the bottom surface of the sand. The small particles of sand fall between the sprigs and all foreign material gravitates toward the lower end of the hopper where it may be removed while the machine is in motion. Centrifugal force, exerted at the point where the belt emerges from the hopper and passes around the pulley, discharges the fine sand from the sprigs. The sand is aerated by being thrown through the air.

In the machine having a capacity of 400 pounds of sand per minute,

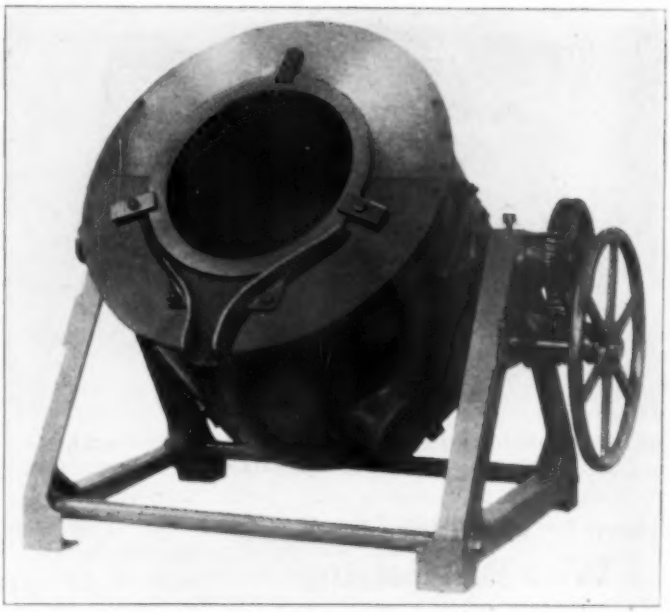
which is shown in the accompanying illustration, the width is 2 feet 6 inches, the length 3 feet, the height 3 feet 4 inches and the weight 570 pounds The machine is driven by a 1 horsepower motor. The second size, with a capacity of 700 pounds of sand per minute, is operated by a 1½ horse power motor and is 2 feet 11 inches wide, 3 feet 10 inches long and 3 feet 10 inches high, the weight being 700 pounds.

The largest size is made in both the portable and stationary types, and has a capacity of 1000 pounds of sand per minute. The stationary type is operated by a 3 horsepower motor, is 2 feet 2 inches wide, 4 feet long and 3 feet 4 inches high, weighing 1450 pounds. The portable machine is 3 feet 6 inches wide 4 feet 9 inches long, 4 feet 4 inches high and weighs 1550 pounds.

Designs Stationary and Tilting Furnaces

A furnace designed to melt 100 pounds of aluminum per hour at 1350 degrees Fahr. recently has been introduced by the F. A. Coleman Co., Cleveland. This furnace is built in both stationary and tilting types and the pot, shells, linings, bottom plates, burner castings and flue castings are interchangeable between the same sizes of stationary and tilting types. The pouring lip is fastened to the top plate and may be replaced by loosening two nuts carried by stud bolts set in the top plate.

The stationary furnace is arranged so that some of the exhaust gases may be passed up and over the top of the pot and out through the holes in the cover. The refractory lining is 7½-inches thick and has an annular exhaust flue near the top. On the stationary type the adjustable cover is hung from the arm which turns on a steel pin forced in the top plate, while the tilting type has no cover. The furnace is built in two sizes of 300 and 500 pounds capacity respectively. In both sizes the diameter of the to plate is 41 inches, the diameter of the shell is 38 inches, the inside diameter of the pot 20 inches, the thickness of the shell ¼-inch and the floor space required is 38 x 50 inches. The height of the smaller furnace is 33 inches while that of the larger one is 39 inches. The depth inside the pot is 18 and 24 inches respectively. Either gas or oil may be used as fuel. A view of the tilting type furnace is shown in the accompanying illustration.

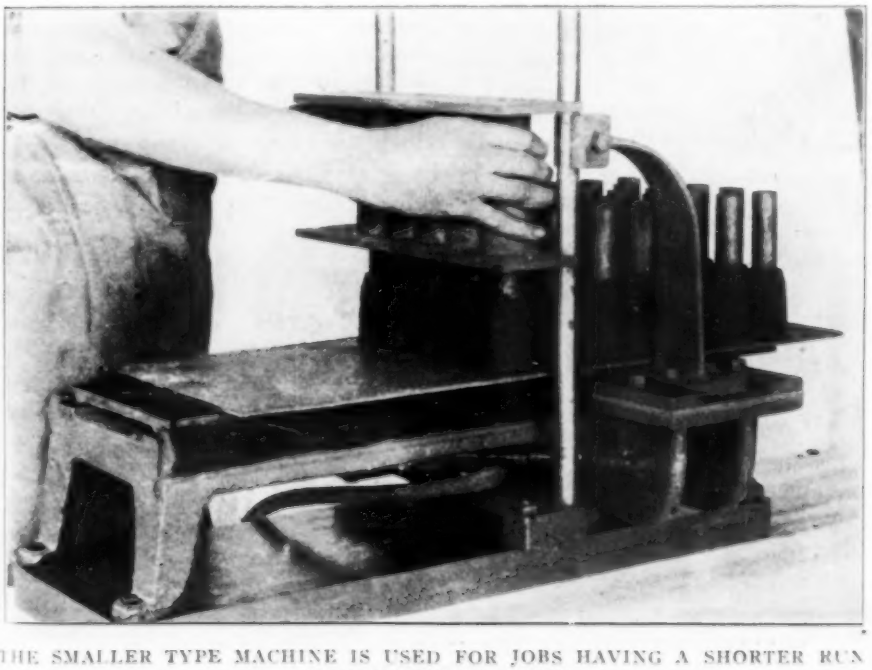


THE TILTING FURNACE HAS PARTS INTERCHANGEABLE WITH THE STATIONARY TYPE

Builds Core Machine

The Skeppstedt-Erickson Co., Moline, Ill. has introduced a new core machine on which gang core molds are used. The machine, which is shown in the accompanying illustration, is designed for jobs having a short run and for core boxes requiring a sensitive vibration.

Vertical rods connected by a cross bar carrying a vibrator engage notches on the side of the core box. A knee valve actuates and controls the operation of the vibrator. Through the vertical rods the vibration is transmitted from the vibrator to the core box. In addition, the vertical rods and notches on the side of the core box serve to guide the box during the drawing operation. It is claimed this combination makes possible a perfectly straight draw. Solid boxes are used, thus eliminating the fin formed by the joint. The machine has a movable carriage. After each box of cores has been made the carriage is moved to make room for the next bunch of cores.



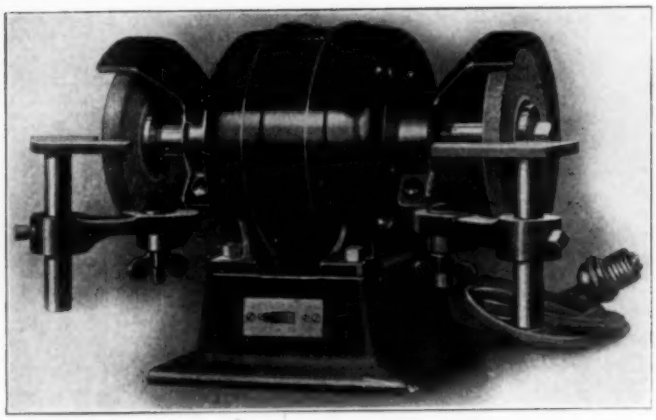
THE SMALLER TYPE MACHINE IS USED FOR JOBS HAVING A SHORTER RUN AND FOR SMALL WORK

Suitable Molding Sand

Question—I have a large amount of silica sand and would like to know if it would be satisfactory for molding sand for steel castings. The sand is of the following composition:

	Per cent
Silica	98.81
Iron oxide	0.46
Alumina	0.59
Magnesia	Trace
Lime	0.11

Answer—The composition you give of your silica sand would indicate that the sand is good for core work and as a molding sand for steel castings. However, we could not definitely determine this unless we saw a sample of the sand representing the average quality and fineness, the physical characteristics of the sand being as important as its composition.



GRINDER DESIGNED FOR USE WHERE THE DEPARTMENTAL SYSTEM IS EMPLOYED

Bench Grinder Is Built With Ball Bearings

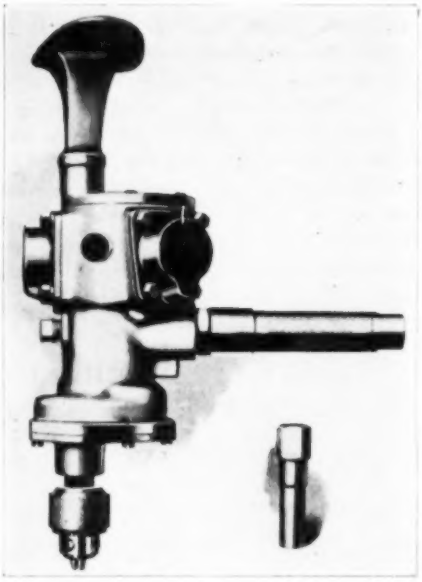
An improved type of grinder for use in connection with the departmental system of handling grinding recently has been placed on the market by the Bodine Electric Co., 2254 W. Ohio street, Chicago. This grinder has a number of features which make it adaptable to this system of grinding. The grinder shaft operates on ball bearings on each side of the motor, with the result that the device is smooth running.

The tool rest is easily adjustable to any position through the operation of a thumb screw. The rest may be pivoted or held rigid as desired, and may be adjusted vertically. The motor is protected by a dust proof covering while a heavy guard prevents particles of dust from flying toward the operator, and decreases the possibility of accidents. The grinder is provided with a cord and plug and can be attached to the lighting circuit. A view of the machine is shown in the accompanying illustration.

Tumbling Mills Have Roller Bearings

The Royersford Foundry & Machine Co., Inc., Royersford, Pa., has equipped the tumbling mills of its manufacture with substantial roller bearings to care for the heavy loads to which the tumbling mills are subjected. The bearings are made of solid steel rollers held firmly in a cage of rigid construction, thus keeping the rollers properly spaced. The dust is kept from entering the bearing chamber by felt strips cemented in the grooves at the end of each bearing.

The mills, to which the roller bearings have been added, are of the exhaust type, the air being taken in at one end of the mill through a hollow trunnion. The suction maintained at the opposite end of the mill keeps the air moving from one end to the other, carrying with it the dust and dirt. The mills are made of various diameters and lengths to meet the variety of conditions arising in cleaning gray iron, steel or brass and for removing cores and molding sand. The shells are rolled from high grade tank steel. The lid or door is made the entire length of the mill and is held in place by a flat steel bar running parallel with one outside edge of the shell. Clamps are provided to hold the other side of the door in place when in operation.



DEVICE FOR LIGHT DRILLING AND REAMING

Develop Pneumatic Drill

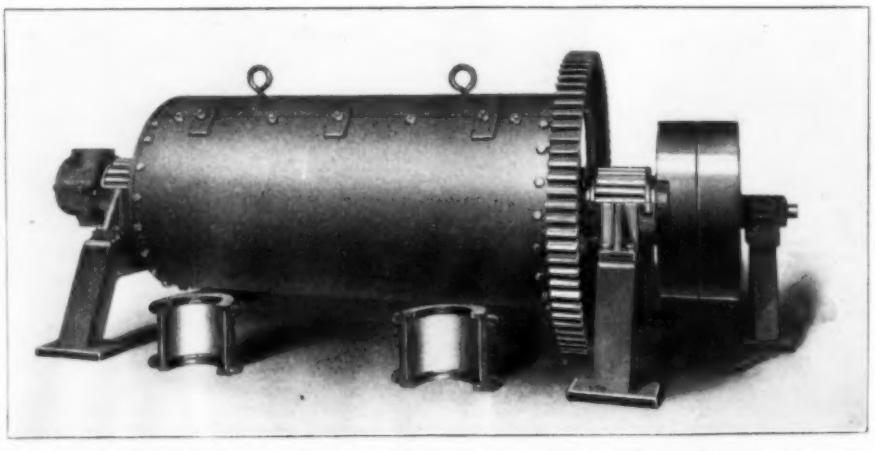
A new size, lightweight, nonreversible, pneumatic drill has been developed by the Ingersoll-Rand Co., New York. This drill is suitable for drilling holes up to 9/16 inches in diameter and reaming up to 5/16 inches in diameter. The device may be adapted to a wide variety of work by fitting with either breast plate, feed screw or grip handle. The features claimed for this tool are the light weight aluminum case, steel bushings cast in all bearing holes and throttle hole, renewable and interchangeable cast-iron cylinders and a special, three-cylinder motor. The three-cylinder motor has the rotating parts accurately balanced as a protection against vibration and to reduce wear on the machine. The recommended working speed at 90 pounds air pressure is 700 revolutions per minute. The weight of the machine including the breast plate and chuck is 14 pounds. The length of the feed is 2½ inches, the length overall 15 inches and the distance from center to side of spindle 1½ inches.

Moves Sales Office

The Raymond Bros. Engineering Co., Chicago, manufacturer of machinery and equipment for preparation and utilization of pulverized coal, has removed its general sales office to the Combustion Engineering Corporation building, 43 Broad street, New York.

H. D. Savage, vice president and general manager, Combustion Engineering Corp., will be in charge of sales.

Charles F. Miller, presented a paper on foundry production problems before the foundry association of the Wentworth institute, Boston, treating on the subjects of executive control, patterns, molding machines and the personel. Mr. Milles is the superintendent of the Universal Winding Co., Providence, R. I.



ROLLER BEARINGS ARE PROVIDED TO ASSIST IN CARRYING THE HEAVY LOADS

Equipment Buying Is Lagging

Slight Falling Off Is Noted in Volume of Inquiries Being Brought Out—Buyers Continue To Delay Closing—Several Manufacturers Busy With Repair Work

SALES of foundry equipment generally continue to show a slight falling off. Likewise, inquiries are not being brought out in as heavy a volume as was reported several weeks ago. However, in some quarters manufacturers report a fairly heavy repair business, indicating foundries are fairly busy. The W. W. Sly Mfg. Co., Cleveland, has sold tumbling mill equipment to Chisholm & Moore Mfg. Co., Cleveland and the Dayton Steel Foundry Co., Dayton, O. The same manufacturer is furnishing tumbling mills and dust arrester equipment to the Taylor & Boggis Foundry, Cleveland, and the Ohio Stove Co., Portsmouth, O. The Pangborn Corp., Hagerstown, Md. recently sold sand-blast equipment to the Springfield Malleable Iron Co., Springfield, O.

Western Demand Is Light

SEVERAL manufacturers of foundry equipment in the Chicago district have received greater inquiry in the past few days, but a majority report a decrease both in inquiry and in sales. Some manufacturers feel that the slack period, calling for economics, gives them additional argument for the installation of labor-saving equipment. Sales of the National Engineering Co., Chicago, of their sand mixers include units to the Chicago Foundry Co., Chicago; the Pacific Malleable Castings Co., Oakland, Cal., and the General Boilers Co., Waukegan, Ill. The W. W. Sly Mfg. Co., Cleveland, has sold a sand blast mill equipped with an elevator and pressure tank to the Terre Haute Malleable & Mfg. Co., Terre Haute, Ind. The same manufacturer has sold tumbling mill equipment to the Willys-Overland Co., Toledo, O.; the Frank Foundries Corp., Davenport, Ia.; and the Wisconsin Cylinder Foundry Co., Racine Junction, Wis. Sand blast and dust arrester equipment has been sold to the Geo. H. Smith Steel Casting Co., Milwaukee, and the Davenport Machine & Foundry Co., Davenport, Ia., by the Pangborn Corp., Hagerstown, Md. Sand-blast equipment has been ordered by the Tennent Steel Casting Co., Seattle, the Packard Motor Car Co., Detroit, and Fairbanks, Morse & Co., Chicago, from the Pangborn Corp. The Royersford Foundry & Machine Co., Inc., Royersford, Pa., has sold tumbling mills to the Blackmer Pump Co., Petoskey, Mich., and the United Brass & Aluminum Co., Port Huron, Mich. A manufacturer of flasks and wheelbarrows in this district reports that orders are heavy for this type of equipment.

Demand Spotty in East

DEMAND for foundry equipment in the East is spotty. The improvement noted recently is no longer in evidence, and sentiment is less optimistic. Seasonal influences have not been felt to the extent anticipated. An interesting sale calls for a 5-ton and a 3-ton crane ladle for shipment to Cuba, this business being placed through Zaldo & Martinaz, New York, with the Whiting Corp., Harvey, Ill. This latter interest also has booked some brass foundry equipment for the Bordens Co., dairy interest of New York. The Mansfield Foundry Co., Mansfield, Mass., which is making a small extension to its plant, recently has purchased some equipment, including a 10-ton electric crane, with 27-foot, 6-inch span, the order being placed with the Pawling & Harnischfeger Co., Milwaukee.

The Central Foundry Co. is expected to be in the market shortly for equipment for a $30,000 addition to its Newark, N. J., plant. The Driver-Harris Co., Harrison, N. J., is inquiring for an electric furnace, and the Riverside Steel Castings Co., Newark, N. J., is negotiating for a tumbling barrel. The Trenton Malleable Iron Co., Trenton, N. J., will start work shortly on the construction of a building to replace that portion of its plant recently damaged by fire with a loss of $22,000. The Buch Sash Weight Co., Lebanon, Pa., recently organized, plans the establishment of a gray iron foundry. The Bullard Machine Tool Co., Bridgeport, Conn., reported recently as contemplating the erection of a steel foundry, has officially denied this rumor.

The W. W. Sly Mfg. Co., Cleveland, has sold a tilted blast mill to the Singer Mfg. Co., Elizabethport, N. J., and tumbling mill equipment to the Vulcan Iron Works, New Britain, Conn. Tumbling mills have been sold to the Magee Furnace Co., Inc., Taunton, Mass., the Geneva Foundry Corp., Geneva, N. Y., and the E. L. LeBaron Foundry Co., Brockton, Mass., by the Royersford Foundry & Machine Co., Inc., Royersford, Pa. The Pangborn Corp., Hagerstown, Md., reports the sale of sand blast and dust arrester equipment to the Marcy Foundry Co., New York.

Little Business in Pittsburgh District

THE decrease in activity among many foundries in the Pittsburgh territory is evident as having a depressing effect upon the market for foundry equipment. Sales of foundry equipment have been few and far between. The Herman Pneumatic Machine Co., Zelienople, Pa., reports that while it is working on a number of inquiries for molding machines, the only sales noted recently include two additional machines to the National Foundry Co., Erie, Pa., and one each to the General Steel Casting & Machine Co., Newark, N. J., the Vulcan Iron Works, Wilkes-Barre, Pa., and the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa. Several inquiries are out for various types of foundry equipment, including cupolas, core ovens, and sand machinery. Those pending include one from Canada for ladles, molding machines, etc., from the James Bros. Foundry Co., Perth, Ont. The Chase Metal Works, Waterbury, Conn., the Standard Sanitary Mfg. Co., New Brighton, Pa., and others, have purchased furnace control apparatus from F. J. Ryan & Co., Philadelphia. Among current inquiries for miscellaneous material and equipment is that of the Waterhouse Bros. Brass Foundry Co., Wood street, Wheeling, W. Va. Sand blast and dust arrester equipment has been ordered from the Pangborn Corp., Hagerstown, Md., by the York Safe & Lock Co., York, Pa., and the Pittsburgh Grey Iron Foundry, Inc., Pittsburgh. The W .W. Sly Mfg. Co., Cleveland, has sold tumbling barrel equipment to the Pressed Steel Car Co., Pittsburgh. The Eastern Foundry Co., Boyerstown, Pa., the Freed Furnace Co., Oaks, Pa., and the Keystone Stove Foundry, Spring City, Pa., have

purchased exhaust tumbling barrels from the Royersford Foundry & Machine Co., Inc., Royersford, Pa. Spasmodic inquiries appear for wheelbarrows, flasks, riddles, etc., as needed, but these have not been numerous.

The crane and hoist market has been fairly active with inquiries and orders from various foundry operators. The J. L. Mott Co., Trenton, N. J., purchased a 10-ton electric traveling crane with 32-foot span from the Pawling & Harnischfeger Co., Milwaukee, and the Vulcan Iron Works, Wilkes-Barre, Pa., purchased a 10-ton electric overhead crane from the Milwaukee Electric Crane & Mfg. Co., Milwaukee. The H. K. Porter Co., Pittsburgh, is reported to have placed two small cranes with a Michigan builder and the Standard Steel Car Co., Butler, Pa., bought four 4-ton special hoists from the Shaw Crane Works, Muskegon, Mich. The General Electric Co., Schenectady, N. Y., is understood to have withdrawn its inquiry for a 50-ton electric crane for Erie, Pa., and the Westinghouse Electric & Mfg. Co. has taken no action as yet on 12 cranes for its Sharon, Pa., plant.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

Central Foundry Co., 51 Lockwood street, Newark, N. J., plans 1-story addition to its cast iron pipe foundry.

Wagner Malleable Iron Co., Decatur, Ill., operator of malleable iron foundry, is erecting a 31x33-foot pattern shop.

The Buch Sash Weight Co., Lebanon, Pa., plans a foundry for sash weight production and other iron castings. Dr. H. M. Vastine, is interested.

International Casting Co., New York, has been incorporated for $50,000 by L. Timberg, W. W. Lambert with M. Rotherberg, 261 Broadway, that city, as attorney.

Martin Brass Works, New York, has been incorporated for $25,000 by J. S. Hemingway Jr., W. J. Scanlon and C. Green, with Lord, Day & Lord, 25 Broadway, that city, as attorney.

Waterhouse Bros. Brass Foundry Co., Wood street, Wheeling, W. Va., will remodel the city railway building recently purchased and will install equipment.

The Boston office of the Salem Iron Foundry Co., Inc., Salem, Mass., has been discontinued, Edward P. Brock, formerly representing the Salem company there having resigned.

Geo. H. Smith Steel Casting Co., Clinton street, Milwaukee, has changed the address of its Chicago office to 549 West Washington boulevard.

The U. S. Grapples Co., Salem, Oreg., has been incorporated by Stephen M. Smith, William Underhill and P. J. Smith for $500,000. The company will operate a general steel and iron foundry and manufacturing plant.

Athens Foundry & Machine Co., Athens, O., has changed hands for the third time this year, M. L. Yuster, Columbus, O., having purchased the property from W. L. Wallace, Nelsonville, O.

Chantrell Hardware & Tool Co., Reading, Pa., has started work on erecting a 3-story plant addition, 50x140 feet, costing approximately $55,000. The Chantrell company operates gray iron, brass and aluminum foundries.

A gray iron foundry has been leased by C. A. Sleicher, president of the Interstate Foundry Co., Cleveland, from the receiver of that company. Mr. Sleicher will operate to fill contracts for customers with the Interstate company.

Charles Carnahan, Charles Ulf and Harry Devereaux, Tidioute, Pa., are organizing a company for the erection of a plant to manufacture aluminum and brass products, especially automotive parts.

Maynard Electric Steel Castings Co., Kilbourn road, Layton Park, Milwaukee, plans an addition to increase present capacity from 50 to 75 per cent. S. J. Wabiszewski is president. The company operates a steel foundry.

Beatty Bros., Ltd., Fergus, Ont., manufacturer of washing machines, pumps, tools, etc., is in the market for machinery and tools. W. G. Beatty handles the purchases. The company operates a gray iron foundry.

Trenton Malleable Iron Co., was damaged by fire recently with most of loss confined to gray iron department. The company operates gray iron, brass, malleable and aluminum foundries.

Skinner Machinery Co., Dunedin, Fla., manufacturer of packing house equipment will make oil burning steam and hot water boilers. The Skinner company operates gray iron, brass and aluminum foundries.

The Oxford Foundry & Machine Co., Oxford, N. S., has let construction contracts to Doncaster Bros., Amherst, N. S., for erecting foundry to replace that recently damaged by fire. The new plant will cost approximately $25,000.

Hudson River Foundry Co., Poughkeepsie, N. Y., operator of gray iron, brass and aluminum foundries, has increased its capital stock from 2500 shares to 3750 shares of which 2500 are $100 par value preferred and 1250 no par value common.

The brass foundry of the J. E. Lonergan Co., 211 Race street, Philadelphia, manufacturer of steam specialties and operator of a gray iron foundry, was damaged recently by fire. Approximately $30,000 is to be expended on a new plant.

Riverside Brass & Aluminum Foundry Co., 449 Market avenue, southwest, Grand Rapids, Mich., recently was incorporated for $15,000 with George G. Cady as president, Henry Buskers as vice president and Leonard De Vos as secretary and treasurer.

The American Machine & Foundry Co., Dallas, Tex., manufacturer of sugar and cigaret making machinery, is reported as having arranged for additional working capital to enlarge present business. The company formerly was a subsidiary of the American Tobacco Co.

Lennox Furnace Co., Marshalltown, Iowa, manufacturer of stoves and furnaces, plans constructing a plant at Syracuse, N. Y. The company operates a gray iron foundry. M. Kinnan, 2 Twelfth avenue, Marshalltown, is secretary.

The Southern California Foundry Co., Westminster road, Alhambra industrial district, Los Angeles, plans expansion in the near future, according to Eugene Sanders, secretary and treasurer. The company, recently incorporated, manufactures iron pipe and fittings.

Central Foundry Co., Holt, Ala., has let contract to A. Laycock & Sons, Tuscaloosa, Ala., for dismantling, removing and rebuilding cleaning mill for new foundry. The proposed addition to No. 3 pipe foundry will be 140x420 feet, with a 40x60-foot cupola house.

The Viking Pump Co. of Canada, Ltd., Walkerville, Ont., has been incorporated for $40,000 to manufacture rotary pumps, machinery, tools, iron, steel, brass and other metal products, etc., by Jonathan B. Huyck, Detroit, Mich., Wilbur N. Hostrop and Peter C. Peterson, Cedar Falls, Iowa.

The Athens Plow Co. Athens, Tenn., recently purchased a site where it plans constructing a 60x120-foot plant. Modern equipment will be installed in the foundry, including an electric furnace for producing steel castings. J. G. Stephenson, inventor of the plow to be manufactured, is an organizer of the company.

Carthage Machine Co., 571 West End avenue, Carthage, N. Y., operator of gray iron, brass and alumunim foundries, has purchased the plant of the J. C. Wilson Mfg. Co., Belleville, Ont., operator of gray iron and brass foundries. Plans have not yet been formulated for expansion of the Canadian properties.

Rogers Foundry & Mfg. Co., Joplin, Mo., operator of a gray iron foundry, has acquired the plant of the Joplin Steel & Malleable Co., Railroad and Third streets, that city. Plans are under way for extensions to increase largely the present capacity. John A. Rogers is president of the Rogers Foundry company.

James B. Clow & Sons, Harrison and Franklin street, Chicago, is having plans prepared for a 4-story, 115x200-foot plant at Talman and Lake streets. William Clow, 534 Franklin street, is president. The Clow company operates gray iron, brass and aluminum foundries at Chicago, Coshocton and Newcomerstown, O.

Kelsey Wheel Co., 6100 McGraw avenue, Detroit, operator of gray iron, malleable and brass foundries, plans 1-story, 105x140-foot brick, reinforced concrete and steel constructed plant. Louis C. Brooks, 3600 Military avenue, is secretary. Smith, Hinchman & Grylls, 800 Marquette boulevard, are attorneys.

Putnam Foundry & Machine Co., Putnam, Conn., has been taken over by Leland, Gifford & Co., Worcester, Mass., manufacturer of drills. The Worcester company will operate as the Putnam company, continuing the manufacture of boilers. Contracts have been let for a foundry addition to handle machine tool castings.

P. B. Yates Machine Co., Beloit, Wis., operator of a gray iron foundry and manufacturer of machinery, is converting a large area in the foundry built several years ago, into a machine shop to produce electrically operated molding machines for working wood stock into molding, fancy patterns, etc. Approximately $100,000 worth of shop equipment is being purchased for the new department.